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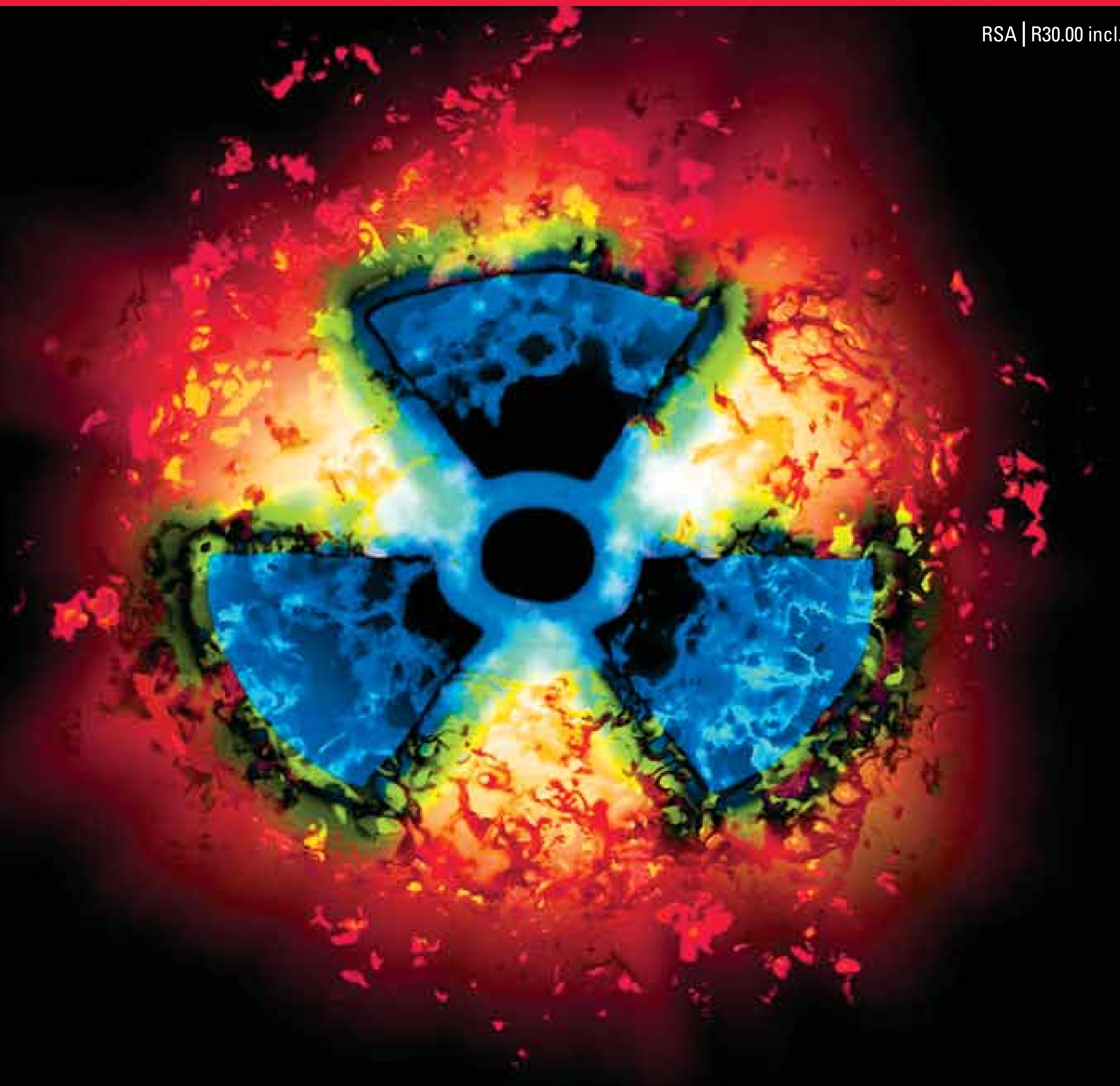

POWER GENERATION
& NUCLEAR ENERGY

SAIEE THE OFFICIAL PUBLICATION OF THE SOUTH AFRICAN INSTITUTE OF ELECTRICAL ENGINEERS | **MARCH 2015**

Conlog has the world's largest installed base of prepaid meters, spanning more than 20 countries on four continents. Furthermore, over 70 utilities worldwide utilise our solutions and consider Conlog their preferred prepayment provider.

With systems that are available in English, Arabic, French, Spanish and Portuguese, our products have been able to reach millions. In addition, as a part of a global group, Conlog has access to a network of offices and resources spanning over 100 countries.

CONLOG
Solutions for utilities

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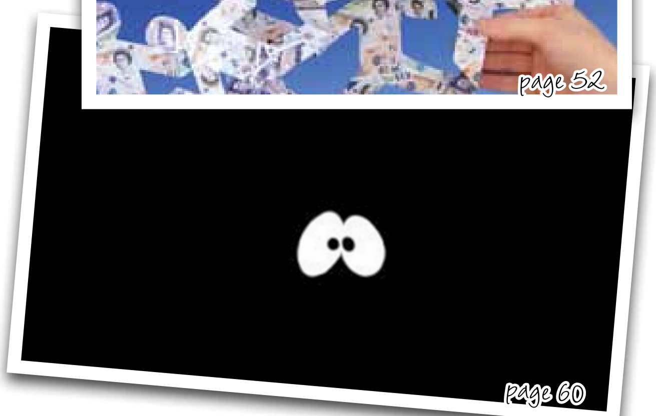

wattnow magazine

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March is upon us, motoring on like a steam train.... waiting for no one. If you are a South African citizen, you would've experienced load shedding, which is, in my opinion, inevitable.

This issue of **watt**now features articles on Power Generation and Nuclear Power, which is something totally different. To quote Deputy Minister Thembi Majola: "To compare coal with nuclear, is like comparing apples with bananas".

This issue sports a nice in-depth article about Coal and its production (pg 24), Nuclear Power (pg 42) and Load shedding (pg 46).

I've kicked the hornet's nest once again with the February issue of **watt**now.

Your February issue of **watt**now had your correct address but an incorrect name – but it was done on purpose – why?
So we could gauge who read their flysheet – why?
To gauge what marketing value could be attributed to the flysheet – why?
So we could acquire tangible evidence. Guess what?
There has been an enormous response and we now know more or less the contribution of the flysheet.

Thank you for those who participated in the secret survey and we assure you we know your correct name and the huge value you are to our noble institute. We promise not to use these unconventional tactics, unless it is in the interests of all our members.

Herewith the March issue (correctly addressed), enjoy the read!

Minx

Earn CPD Credits

*Visit www.**watt**now.co.za to answer the questions related to these articles to earn your CPD points.*


"Share a little to save a life"
The Sunflower Fund recruits donors to help those suffering from leukaemia and other life-threatening blood disorders.
It takes only 2 tubes of blood to be tested to become a donor and join the SA Bone Marrow Registry. If you are a match for a patient, your bone marrow stem cells are harvested in a process similar to a blood donation. No surgery is required.
The Sunflower Fund
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Greetings from SAIEE House!

In February, Radio 702 reported that South Africa has become the world's favorite destination for Valentine's Day Celebrations; dinner by candlelight. In February, The President delivered the State of the Nation Address. Energy was agenda number one of the nine point national plan for growth and prosperity.

Energy, as in electrical energy and Eskom, will continue to be the agenda with which we will grapple as we journey through 2015, and the next few years. There is hope. I have confidence that we will help make the difference as members and as The Institute of Electrical Engineers.

Under the leadership of Honorary Fellow, Dr. Ian McRae, Office Bearers are in discussion on "Electricity South Africa". We have selected four time periods for the packaging of ideas, strategies and contributions to enhance our national electrical energy performance. The selected time periods are real time, short term, medium term and long term. For each of these time periods, we are collecting from members, their ideas and strategies for action.

For example, under the real time category, we want an intensive focus on load shedding operations. We propose to facilitate national and regional customer forums to collate the customer inputs for load management. We understand that load shedding is an accepted practice to manage the imbalance in supply and demand. The emphasis is on accuracy, certainty and predictability. The economic impact and the negative effect of the temporary reduction in electricity could be minimized. Another example, under the short term category, we want an intensive focus on the maintenance of the plant and equipment at our national power stations, at our substations and power lines of transmission and distribution.

We propose to facilitate asset management forums that will help enhance maintenance practices and processes. We plan to promote local supplier support and development initiatives. Our aspiration is the longer term sustainability of the total power system.

When all the analysis is complete, we will find that human resources are the key to all our challenges. We need a stronger focus on growing and nurturing our people resources: our artisans, technicians and engineers. Every person associated with the power system must be a member of the Institute. Our drive is to grow world-class engineers, technicians and artisans. The same effort must be applied to water works, road, rail and transportation networks, telecommunication and information networks and for all engineering infrastructure. Our people make the difference.

During the past month, I had the opportunity to travel with the Eskom Board to Medupi Power Station. Matimba, its immediate neighbor, a giant in its own right, appears small when compared to Medupi. Thousands of South African artisans, technicians and engineers are busy at work. Unit 6, a super critical boiler powering an 800 MW synchronous generator, will be commercially available for the winter of 2015. Units 5,4,3,2 and 1 are in various stages of construction. Medupi, Kusile and Ingula are all racing towards commercial operation. South Africa will soon have an installed capacity of + 50 000 MW. Eskom, the African Power House, is rising!

Very soon, we will all have short memories of load shedding and you will be promoting red hanger energy sales. Keep up the confidence and continue to grow your consumption of South Africa's quality electrical energy. Be good and pay your account. Thank you, work hard and have fun.

Dr Pat Naidoo | Pr. Eng | FSAIEE
2014 SAIEE President

WATTSUP

Global Trends in Hydro Power & African Perspectives

From left: André van der Walt (SMEC Functional Head Power and Energy), Refilwe Buthelezi (SAIEE Power Section Chair), Pat Naidoo(SAIEE President and Eskom board member), Stephen Reynders (SMEC Section Manager Power and Energey), Saeed Soltani (SMEC General Manager, Hydro and Energy) and Chris Viljoen (SMEC Functional Head, Hydropower and Dams).

Saeed Soltani, General Manager Hydropower and Energy Africa Division of SMEC international (A leading global infrastructure consulting engineering company) presented a lecture to members of the SAIEE Power Section in December 2014 entitled: *"Global Trends in Hydro Power & African Perspectives"*. The presentation focused on:

- Trends on hydro power globally: large to micro, run of river and pumped storage
- Trends across Africa
- Major African Projects
- Funding options
- Operating models and options
- Global Hydro power Challenges

The presentation was followed by a round table discussion on Hydropower in Africa and South Africa hosted by Chris Viljoen, one of South Africa pre-eminent Dam, Tunnel and Hydro Engineers. The discussion focused on challenges and particular projects in the South African Hydropower sphere.

The full presentation can be found on the SAIEE website in the "NEWS" section.

RC60 PowerBank - Revolutionary way in preventing flat batteries

If you have ever run out of battery on your camera, cellphone, laptop, tablet or even your GoPro and been without access to a power source, Red-E has a range of affordable, yet extremely powerful portable chargers (otherwise known as powerbanks) that can charge your device as much as up to three times on selected units!

A particularly impressive unit is the RC60 (6,000mAh) powerbank, the largest in the range. The Red-E 6,000mAh (see image below) unit has three outputs so you can power or charge three devices at the same time.

SAIEE APPOINTED NEW FELLOWS

Mr S G Xulu receives his Fellowship Certificate from SAIEE Deputy President, André Hoffmann

Prof I.E. Davidson receives his Fellowship Certificate from SAIEE Deputy President, André Hoffmann

At the first SAIEE Council Meeting of 2015, Deputy President, André Hoffmann had the pleasure in handing over Fellowship Certificates to a some of the Senior Members who transferred their membership status. The recipients who attended the Council Meeting in February 2015, are Mr S.G. Xulu and Prof I.E. Davidson.

The new Fellows who couldn't attend the Council meeting are: Mr L.W. Anthonissen, Mr J J Daniel, Mr G Donachie, Dr B J Kotze, Prof P Naidoo, Mr V N Ramnarain and Mr S G Xulu.

Aurecon earns 'Top Green Service Provider' award from Growthpoint Properties

Aurecon is committed to delivering sustainable and environmentally responsible building projects and has ensured that its project teams comprise suitably trained and registered professionals, ranging from engineers to Green Star SA Accredited Professionals.

In line with this, the company was recently honoured as 'Top Green Service Provider' by Growthpoint Properties. "Our work with Growthpoint has included partnerships on flagship green projects, such as Lakeside, Grundfos offices and warehouse and the new Discovery head office in Sandton. The award demonstrates our companies' shared passion for sustainability and the delivery of cutting-edge and sustainable design options that demonstrate technical excellence and value," says Martin Smith, Aurecon's National Green Building Expert.

Green rated buildings require a holistic approach to buildings, seamlessly integrating sustainable development, engineering, planning and design to produce efficient, sustainable buildings.

WATTSUP

400kV Transmission line spanning 89km's - a significant achievement for Eskom and CONCO

CONCO CEO, David van Zyl (left), hands over a plaque to Eskom Executive Projects Manager, Bob Naraghi at the official handover.

A major milestone for the CONCO group is the three-year construction of a 400kV, 89 kilometre long transmission line for Eskom, stretching from Eros substation near Harding in KwaZulu-Natal, towards Vuyani substation in Mthatha in the Eastern Cape. This major project was completed by CONCO and officially handed over to Eskom last year.

Commenting on the success of the project, Sugan Naidoo (Eskom Project Engineer) says, *"The CONCO relationship with Eskom was professionally handled with Eskom's requirements being met in terms of delivering the project according to specifications. The contract management was executed with excellence."*

"The handover was well received by Eskom for the first section of transmission line being built in the former Transkei area which is now part of the Eastern Cape," said Mr Naidoo. *"CONCO built 89 kilometres of the 167 kilometre 400kV line and considering this was CONCO's first 400kV line construction project, its successful completion was a great achievement by the efforts of the project team and site workers."*

CONCO project engineer, Joseph Mahlangu says, *"Effective stakeholder communication and project control integration which encompassed communication planning, applying best practised systems and controls, work structure, scheduling, reporting and adhering to the project plan, were key elements to the project's success."*

This is the first 400kV line in the former Transkei area enabling a higher power transfer capability in the area. *"400kV Lines transmit bulk power to feed a large number of customers and can power up a town,"* says Mr Naidoo. *"When the line is placed in commercial operation, the current power shortfall in the Mthatha area and surrounding towns will be relieved and will strengthen the network by supplying sufficient capacity to the area for economic growth."*

Commenting on the choice of equipment, Mr Naidoo says, *"The steel lattice structures were used to carry a three phase, triple conductor bundle together with an earth wire and optical ground wire. Some of the span lengths were greater than 1000 metres. Steel structures were used due to their durability and ability to carry the required mechanical loads."*

Approximately 400 people worked on the project over a three-year period. During that time, over 200 temporary employment opportunities were created in the local villages. CONCO also donated 200 desks, 100 chairs, a microscope and a projector, to Dudumeni High School in Flagstaff.

"The Eros/Vuyani project is a milestone for the CONCO group," says Mr Mahlangu. *"It's the first 400kV project executed by CONCO and we have proved our ability to project manage, engineer and construct a transmission line of this dimension. We completed it on time, within budget and to the highest quality."*

Traco Power TSP–REM Redundancy Module

Traco Power has launched their new TSP–REM Redundancy Module for use with the TSP Din-Rail Industrial power supplies.

With this module and two Din-Rail power supplies of the TSP series (of same type) a highly reliable, truly redundant power system can be configured without any additional components. This module enforces the equivalent sharing of the output current by each power supply. The system is fully redundant and provides output power even if one power supply has completely failed e.g. by short circuit on the output. In the event of either power supply failing or being disconnected, the second unit will automatically supply the full current to the load.

The redundancy of the system is monitored and if lost, indicated by an alarm output. The inputs are hot swappable and can be loaded up to 15 A each. The unit is also fitted with a remote ON/OFF system.

The TSP-REM requires two 24V DC inputs and the unit has a maximum input of 360 watt pet input. The output voltage is adjustable from 24 to 27VDC.

The unit has a true industrial design and a rugged metal case for harsh industrial environments.

For more information please contact
Conical Technologies on 012 347 5035 or tracopower@conical.co.za

Significant Uptake in Demand for Key Products

Shaw Controls, a company of the Zest WEG Group, has seen a significant increase in the demand for key products such as electrical houses (E-Houses), fully withdrawable motor control centres (MCCs) and modular variable speed drives (VSDs). This has resulted in the Zest WEG Group committing to a major expansion drive at Shaw Controls as the Group expands its manufacturing capability in order to boost its presence in the local market and also in Africa, which is perceived as a major growth area.

While the Zest WEG Group is well known for distributing one of the largest electric motor ranges in the world from WEG of Brazil, our comprehensive product line up includes switchgear, VSDs, MCCs, gensets and renewable energy solutions. We also have three fully fledged manufacturing facilities in South Africa that we are in the process of expanding as we increase our footprint in Africa," Louis Meiring, CEO of the Zest WEG Group, says.

Bevan Richards, Managing Director of Shaw Controls, reveals that next year it will embark on the design and establishment of a standalone E-House and container conversion facility.

"We are anticipating a 4 000 m2 facility to be able to handle these products, which represents a major extension of the Zest WEG Group's local manufacturing capability," Richards says.

"The Zest WEG Group as a whole has the management team and overall company structure in place to be able to handle projects of a much larger nature and to provide the customer care needed on multiple projects for different customers, and to do so efficiently and cost effectively."

In addition, Shaw Controls is in the process of establishing a centralised bulk store for the receipt and issue of all goods in line with its new inventory control system. *"We are fully committed to the ISO 9001 process."*

Richards says that the growth and expansion at Shaw Controls dovetails with the overall strategy of the Zest WEG Group. *"We are integrating our product range with those of the other Group companies involved in large scale turnkey projects. This represents a huge opportunity for us to add value to our own product range by capitalising on*

Lebo Ntete in the dedicated electrical workshop for the production of main and sub distribution boards at Shaw Controls.

the knowledge and experience of the entire Group."

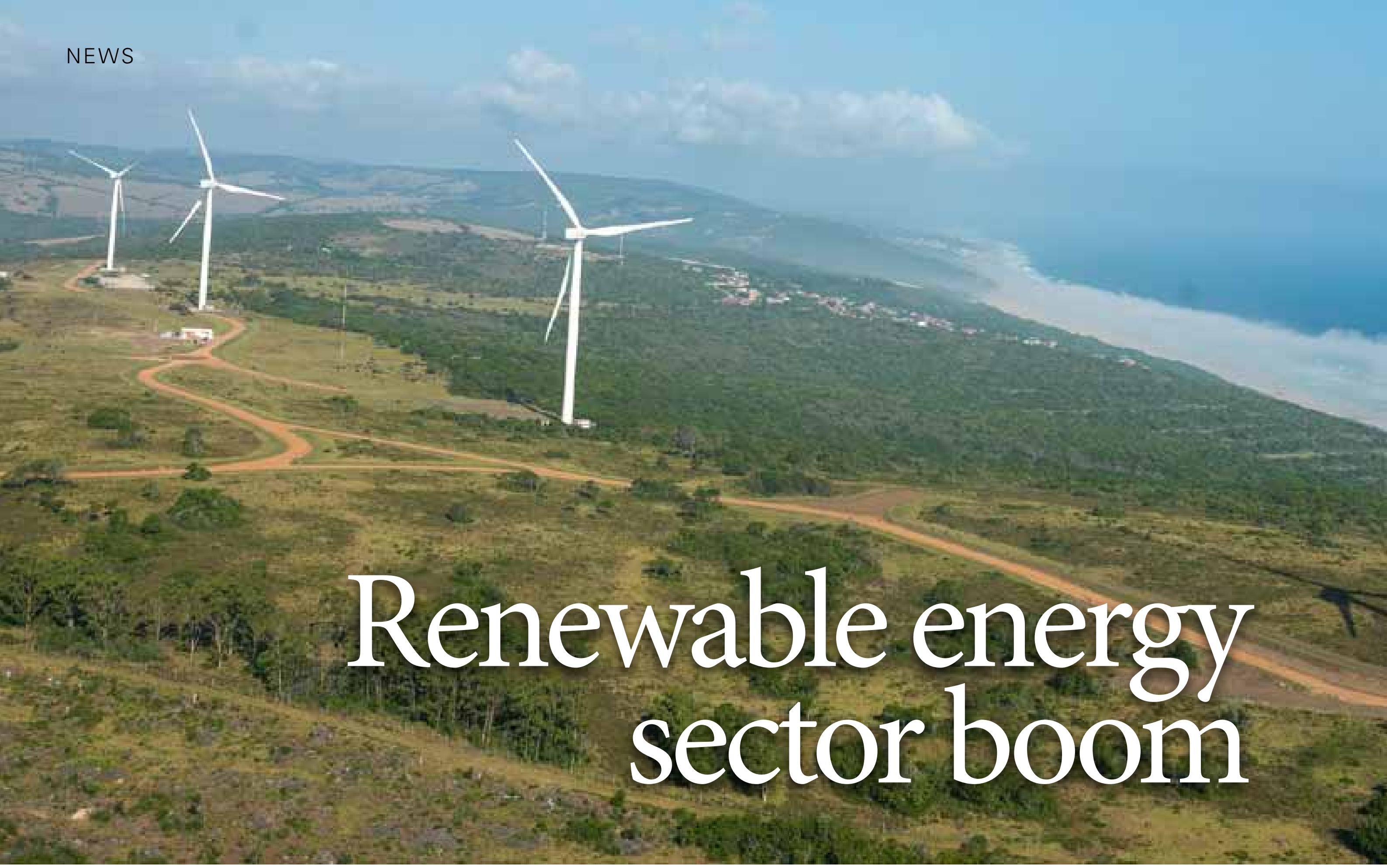
The E-Houses from Shaw Controls represent a particular innovation for the South African market in that they are a cost effective alternative to traditional containerised solutions manufactured in either 6 m or 12 m standard marine containers. *"The main benefit of the E-Houses is that they can be manufactured to customised dimensions, which is a testament to the flexibility of Shaw Controls."*

Shaw Controls also supplies WEG modular VSDs for loads of up to 2.5 MW at 690V. *"Whereas modular VSDs were previously built and assembled by WEG of Brazil, we as the South African arm of WEG will in future develop the enclosures and populate them with modular VSD components from WEG,"* Richards reveals. *"The advantage of these modular VSD products now being assembled in South Africa is that it represents a substantial reduction in the lead time of any project."*

Santos Ferreira, product development specialist at Shaw Controls, reveals that all the company's products have now been tested to the latest IEC 61439-1 standard. *"We have developed various ranges of our switchboard products, namely SC 100, SC 200 and SC 300, for various applications at different fault levels and current ratings."* The maximum rating that all products have been tested at is 690V+5% @ 65 kA. *"In addition we are in the process of locally developing the WEG range of fully withdrawable MCCs. This product range is suitable for all types of process type industries and will add great value to Shaw Controls' product range,"* Ferreira adds.

Richards concludes that it's all systems go for the future expansion at Shaw Controls and its continued integration into the Zest WEG Group's total solutions approach to the requirements of its diverse customer base. *"Our business is customer focused and as a result we strive to provide the best service and support possible. Meeting the needs of our customers is of fundamental importance."* wn

Albert Chauke proudly displays the range of cable reels available at Shaw Controls.



Renewable energy sector boom

Following significant growth in its renewable energy business, AfriCoast Engineers SA has developed a sister company to expand its vision.

NEWS

The leading engineering firm announced that new company, AfriCoast Energy, will now be responsible for all future renewable energy projects – particularly wind and solar – while it will also play a key role in guiding AfriCoast Engineers' current basket of renewable energy projects.

John McGillivray, former project director at AfriCoast Engineers SA, has been appointed chief operating officer at AfriCoast Energy.

"AfriCoast Engineers SA's growing footprint in the renewable energy sector over the past ten years led to the establishment of AfriCoast Energy to follow opportunities within the renewable energy and sustainability sectors. We are pursuing large, medium and small scale renewable energy projects with a collective capacity of over 2000 MW, working closely with energy developers, investors, the state and private landowners," McGillivray said.

Over the past decade AfriCoast Engineers SA has played a catalytic role in bringing renewable energy projects online in the country. To date it has delivered projects collectively worth over R4-billion for its local and international client base.

In the first stage of the Department of Energy's Renewable Energy Independent Power Producers Procurement Programme (REIPPP), the firm initiated three out of four of the successful Eastern Cape projects between 2011 and 2014, and a successful round three project.

WINDS OF CHANGE: AfriCoast Engineers SA directors (left) Donald McGillivray and Venance da Silva (right) congratulate John McGillivray (centre), chief operating officer of AfriCoast's newly established sister renewable energy company, AfriCoast Energy.

Now, through AfriCoast Energy, it will continue to provide the expertise that has been at the core of renewable energy projects such as the MetroWind Van Stadens, Gibson Bay and Kouga windfarms, and the Dobbin, Brakpoort, Hopewell and Coega solar projects.

McGillivray, an engineering project management and consulting veteran of projects in England, South Africa, Australia and the United States spanning over two decades, said AfriCoast Energy has laid out an ambitious plan to continue pioneering new models in renewable energy development for government, communities and private sector entities.

"We were privileged to work with Amatola Green Power in pioneering embedded generation and energy trading in South Africa through an innovative trading model and a ground-breaking agreement with the Nelson Mandela Bay Municipality in the Eastern Cape. We would like to extend this concept to the remaining provinces of the country," he said.

McGillivray said his team will focus on the entire lifecycle of renewable energy projects; from identification and permitting, through to construction and operation. This will provide much needed diversification and stability to the local and national energy supply, while enabling sustainable development, job creation and growth in South Africa.

"AfriCoast Energy also provides strategic sustainability planning to assist government departments with the implementation of low carbon and climate resilient interventions and to ensure that opportunities within the green economy are fully developed for the Southern African market," he said.

Chairman of AfriCoast Engineers SA, Venance Da Silva, said he is optimistic about the future and development of renewable energy in South Africa, and believes the Eastern Cape will lead the race over the next few years by sharing its expertise with the Southern African market.

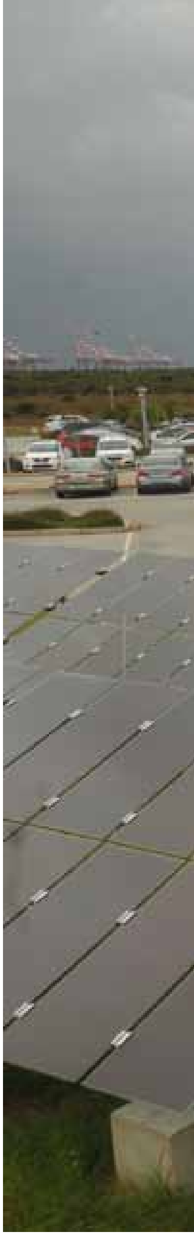
The province is set to become a leading wind and renewable energy hub in an effort to help the Department of Energy meet its procurement objectives of 3 725 MW of renewable energy.

"The formation of an entirely new company along with our existing track-record will enable us to play an important role in leading the country and continent's renewable energy renaissance."

"We are strategically positioned, drawing on an already established local green economy through the renewable energy component manufacturing and export hubs of Coega IDZ, the ongoing research of the local academic community and our own engineering track record in renewable energy projects," he said. wn

Energy efficiency takes the lead in the Eastern Cape

THE Coega Development Corporation (CDC) Friday (subs: 30 January 2015) announced the installation of solar panels at its headquarters in the Coega Industrial Development Zone (IDZ) in Nelson Mandela Bay.



The installation forms part of the organisation's deep commitment to alternative energy sources such as renewable energy, in order to save on electricity, as well as environmental stewardship and an ongoing drive to management innovation.

"The solar panels will supply 48kW (approximately 25%) of solar energy to CDC's corporate head office, and echoes our passion in introducing ways how we believe companies can improve their eco credentials while diversifying energy security," said Vuyokazi Tyida, CDC investment promotion manager.

The solar installation incorporates concrete foundations, thin-film components, and three sets of 15kW inverters.

The CDC's initiative to install solar panels is in line with government's strategy to use renewable energy (wind, hydro and solar) as part of national programme diversifying the country's national energy mix. It also reflects on CDC's success and location as Africa's green energy component's manufacturing hub.

"This move further strengthens CDC as the green economy IDZ. Apart from providing green power, CDC plans to roll out rooftop solutions for all investors located in the IDZ as phase two of this project in order to reduce investor's electricity bill," said Tyida.

Other energy projects in the IDZ include the R3.5 billion Dedisa Peaking Power Plant; the R12 million Powerway/Sungrow JV manufacturer of power supply equipment for solar PV and wind power projects; Powerway/JA Solar JV a R666.6-million investment, the world's largest manufacturers of high performance solar power products; and DCD Wind Towers which launched its R300-million, 23 000m² wind tower manufacturing facility in March 2014 in Zone 3.

In line with its vision to become the leading catalyst for socio economic growth and local beneficiation, the organisation brought in a number of local SMMEs to help out on the project and assure skills beneficiation.

"We used a number of Port Elizabeth (PE) based small businesses in the project including Ubume Construction, Ivor Smith and Studio d'Arc" said Andile Ntloko, CDC SMME unit head.

The project is envisioned to come with a number of spin offs such as improving electricity supply, reduction of carbon footprint; competitive input cost and generally improves the efficiency levels at the CDC.

The installation of the solar panels in the Coega IDZ will help achieve government's target of generating 3 725 megawatts (MW) from renewable energy by 2030 through the Independent Power Producer Programme (IPPP).

"We are proud to contribute to the national renewable strategy. The CDC has built momentum on energy projects and already uses wind and solar energy and will be looking to add biogas and biofuels in the near future," said Dr Ayanda Vilakazi, CDC unit head marketing and communications. wn

GREEN POWER PROJECT: The team behind the initiative are, from left, CDC Business Development market analyst Tony Wang, CDC intern, Papama Mnyamana and CDC investment promotion manager Vuyokazi Tyida stands in front of the solar panels.

SA champions drive technologies for efficiency and productivity

Energy management solutions and efficiency technologies are a means to end the energy crises experienced worldwide, highlighted Jean-Pascal Tricoire, chairman and CEO of Schneider Electric, during his visit and tour of the new Midrand Schneider Electric Campus in Gauteng.

"The convergence of IT and energy technologies, the Internet of things applied to energy, allows increasing control and anticipation in the use of energy and resources. Schneider Electric's technology and expertise is therefore focused on safety, reliability, efficiency and the grid, encompassing both industrial and green automation innovation," he added.

Representatives from the French Development Agency, Angolan Trade Commission, the French Embassies in Bostswana and South Africa, and members of the local media, were invited to join Tricoire and Mohamed Saad, Senior Vice President for Africa and the Caribbean, on a 360-degree Schneider Electric experience at its new 12,000 square metre site.

The site houses the company's manufacturing operation, and is also the new home of its mining team, which services the whole of Africa, its Sustainability Development Business Unit and Low Voltage Electrical Distribution Division, as well as the Schneider Electric Academy and the company's data centre consolidation initiatives. Employees from the Capital Hill, Bartlett and Germiston sites, as well as certain personnel from its nearby headquarters, have relocated to this site.

According to Schneider Electric, the new building shows a major commitment to the organisation's long-term investment in southern Africa and provides it with more local capabilities, in particular, when it comes to fully servicing its customers by being closer to their needs.

The colocation of all employees on the site is envisioned to assist in greater collaboration.

The Midrand site also forms part of the company's global "Cool Sites" programme, which focuses on designing workplaces that are attractive, inspiring and energising for employees, enabling better employee engagement, productivity and satisfaction levels.

"It is an inviting space for our valuable customers. It perfectly mirrors our brand promise as a global specialist in energy management, with its state-of-the-art elements

From left: Mohamed Saad, Senior Vice President for Africa and the Caribbean
Jean-Pascal Tricoire, Chairman and CEO of Schneider Electric
Eric Leger, Country President for Southern Africa at Schneider Electric

reflecting our central message of efficiency and energy saving," added Eric Leger, Country President for Southern Africa at Schneider Electric.

"Schneider Electric believes in the long-term," emphasised Tricoire, saying that the decisions the company makes today are for the future. *"Africa is an economy of resources. The continent offers a growing population, and numerous young people wanting to learn and build competencies. We are committed to Africa."*

He added that *"if your technology is the best, you must be everywhere in the world"*, and demonstrating this, delegates were given an overview of Schneider Electric's BipBop programme (Business, Innovation, and People at the Base of the Pyramid), which develops collective solutions for comprehensive rural electrification, domestic solutions for energy-related needs, and the business models that make these solutions sustainable. This means that it offers reliable, affordable, and clean solutions; training; and business innovation support to help close energy gaps worldwide. Within this programme, Schneider Electric has created access to energy for 43,837 people worldwide.

"It has been an honour to host Jean-Pascal, who turned a French company into a global operation, managing more than 100 businesses worldwide and leading 185,000 people, as well as Mohamed, who most recently accepted the Africa Best Employer Brand Award for 2014/ 2015, in South Africa," concluded Leger. wn

Schneider Electric ranks 9th in the 2015 Global 100 Most Sustainable Corporations in the World

Schneider Electric announces it ranks 9th in the 2015 Global 100 Most Sustainable Corporations in the World ("Global 100") Index. The index was released by Corporate Knights, the Toronto-based media and investment advisory company, on January 21st.

Companies ranked in the Global 100 index are the top sustainability performers in their respective industrial sectors, selected from a starting universe of 4,609 listed companies with a market capitalization greater than $2 billion (USD). The Global 100 is determined using twelve quantitative sustainability indicators, including the amount of revenue companies generate per unit of energy consumed and lost-time injury rate.

"The Global 100 represents the corporate trailblazers who are forging new ways to make more with less," said Toby Heaps, CEO of Corporate Knights.

"Schneider Electric ranks in the top 10 for the second consecutive year, this is a strong recognition of our continued commitment to sustainability. On a daily basis, Schneider Electric seeks to prove that economic, environmental and social interests are convergent. To have a significant impact and initiate lasting change, a performance measure is required. That is why Schneider Electric has defined specific objectives and measures its results each quarter using the Planet & Society barometer", said Jean-Pascal Tricoire, Chairman and CEO of Schneider Electric.

Schneider Electric has been building its Planet & Society Barometer since 10 years to measure its sustainability performance. The Planet & Society Barometer has been the Group sustainability scorecard since 2005 with objectives defined for a three-year period and quarterly results for its key performance indicators. With each company program, the Group defines a new Planet & Society barometer. The barometer overall progress uses a scoring scale of 10. The final result of the Planet & Society barometer for the 2012-2014 company program was published on February 19th, 2015. However, the barometer had already exceeded its 3-year target of 8/10, and achieved 9.20 (out of a maximum possible 10) in Q3 2014. The next version of the Planet & Society Barometer was presented to external stakeholders on February 19th, 2015.

Wits partners with Ryerson University and India to boost opportunities for Entrepreneurship

Wits University has partnered with Ryerson University in Canada and the Bombay Stock Exchange Institute in India to boost growth opportunities for entrepreneurs and accelerate start-up incubation in the three partner countries.

Professor Adam Habib, Wits Vice-Chancellor and Principal, and Barry Dwolatzky, Professor of Software Engineering at the University and Director of the Wits Joburg Centre for Software Engineering, were present at the launch of the trilateral partnership.

Ryerson has been successful in developing a rich ecosystem for young entrepreneurs. The Canadian University is ranked as one of the top innovative centres in the world. The Canadian government has identified both South Africa and India as key countries for developing and expanding trade and business opportunities.

"This trilateral partnership is exactly the kind of boost that South Africa requires to foster development, innovation and entrepreneurship. The Joburg Centre for Software Engineering at Wits will serve as the catalyst for this initiative through its tech hub in Braamfontein," said Habib.

In 2013, Ryerson Futures teamed up with the Bombay Stock Exchange Institute to bring Ryerson's incubator concept to India, to catalyse the same entrepreneurial opportunities for start-ups in India and Canada eager for access to new markets and new opportunities.

"The partners are developing and expanding a multi-country network of innovation and entrepreneurship zones to drive job growth and opportunities in Canada, India and South Africa," said Ryerson University President Sheldon Levy at the first anniversary of Zone Startups India (ZSI), which is Ryerson's partnership with the Bombay Stock Exchange Institute.

"In just under a year, the Mumbai-based accelerator ZSI has proven to be a thriving hotbed of entrepreneurship – 40 startups, focused on industry connections, an array of supportive networking and learning opportunities and access to a pool of venture capital and angel investors keen to harness the energy and innovation at ZSI," said ZSI Director Matt Saunders.

Nigeria to reach 182 million mobile subscribers in 2019

Pyramid Research forecasts a positive outlook for the telecommunications market in Nigeria, the largest economy in Africa, with the mobile subscriber base growing to 182 million in the coming five years.

According to a report by Pyramid Research, the Nigerian telecommunications market is expected to generate US$10.9 billion in 2019, up from a total of US$9.2 billion in 2013. Although growth in the market will be slightly reduced in 2015, as the market recovers from the large number of fixed-line disconnections, long-term growth of the telecommunications sector will not to be affected. The telecoms market will grow at a Compound Annual Growth Rate (CAGR) of 2% over the next five years, with mobile data increasing at 16% up until 2019.

Severin Luebke, analyst at Pyramid Research, says: "Political instability and low oil prices have led to a depreciation of the Naira against the US Dollar, but the telecommunications market will remain an integral part of the country's efforts to diversify its sources of growth." Although currency devaluations are likely to result in slower US Dollar growth rates, in local currency terms, the Nigerian telecommunications market offers strong growth rates of around 6.8% per year for the period between 2014 and 2019.

Master Power Technologies invests in Kenya

As part of its plan for growth in Africa, Master Power Technologies, power solution and data centre specialists, has recently opened an office in Kenya in order to better service East Africa.

Situated in Nairobi this forms yet another step in the expansion of Master Power's presence in the region so that clients can have easy access to the quality products and technical expertise Master Power has to offer.

Offices in Kitwe and Lusaka in Zambia were recently opened with further African countries earmarked to benefit from a direct Master Power presence.

"We identified a requirement for solutions and products in East Africa, not to mention direct representation and made the decision to have a dedicated full time presence here", says Neill Schreiber, Sales and Marketing Manager at Master Power Technologies.

The Kenyan team is being led by Babeksingh Khalsa who is the Regional Manager for East Africa.

"We are very excited about having a dedicated Kenyan office as this is enabling us to better service our current projects by having a foot on the ground. Projects planned for 2015 will also benefit greatly from this local office" he says.

Khalsa continues *"Plans to increase our market share are underway as we are working closely with associated partners for support and are exploring conducting business within different sectors in the market such as; Oil and Gas, Mining and the Marine Industry in addition to the telecom, financial and general data centre markets".*

"The offices were set up in late 2014 and our aim is to increase our presence here, to include warehousing of products and spares" concludes Schreiber. *"We believe that with our experience in the power and data centre fields we can add real value to the region and assist our East African partners in expanding their knowledge in this field".*

MTN launches unlimited cloud service

MTN has launched a cloud service that provides customers with unlimited storage capacity across a range of devices for a monthly fee of R99. This service which is available to both prepaid and post-paid customers, is payable with airtime, a first in the industry.

Currently, end user customers who subscribe to a cloud service have a limited storage capacity and any storage beyond the prescribed threshold is payable, often run by an international OTT usually paid using a credit card.

Larry Annetts, Chief Marketing Officer: MTN South Africa, says information stored on MTN Cloud is encrypted to ensure security that its security integrity is not compromised and data stored is not screened to enhance privacy MTN Cloud software allows users to sync all their devices, be it smartphones, tablets or laptops, and access stored data from any preferred devices anywhere, anytime.

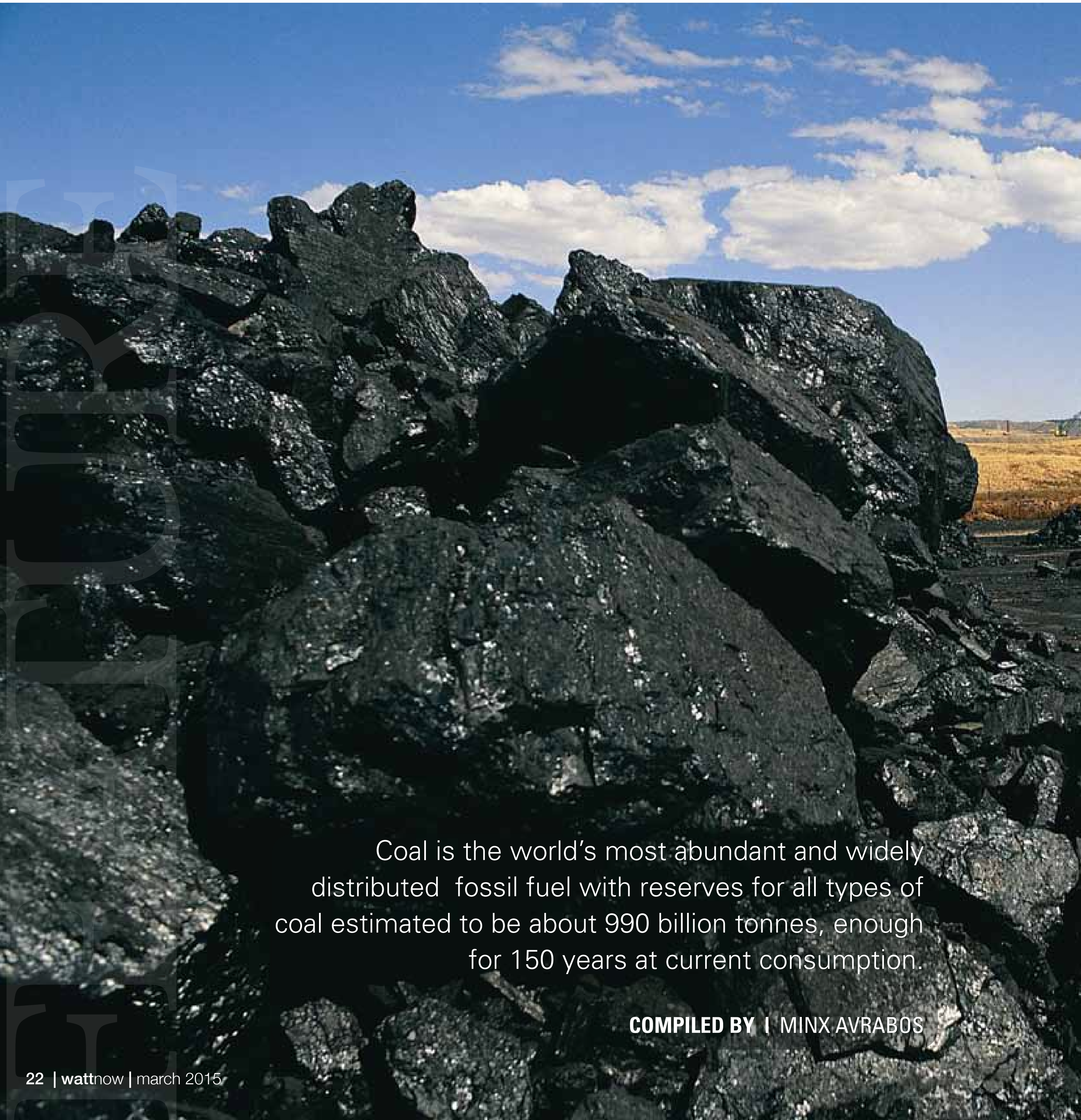
With MTN Cloud, subscribers can seamlessly access and share all their files such as photos, videos and documents remotely on any device using a Mobile Cloud app from anywhere in the world. The app is available on the Andriod and iOS operating systems, however compatibility with other operating systems is being finalized.

"In this digital age the amount of information we collect and store is astounding. It is critically important that consumers have the peace of mind knowing that the integrity of that information, be it business or personal, is not compromised. MTN Cloud ensures that this important data is not only stored for posterity, but is easily and safely accessible as well," says Annetts.

To subscribe to this service, MTN customers need to visit: mtncloud.mtn.co.za from their browser and enter their email address. They will then receive an email with a link to complete the registration. Once a customer cancels their subscription to MTN Cloud, they have a 30 day window period to log on and retrieve their documents. Customers may not be able to add any new documents during this period. *"We continuously strive to develop tailored solutions that are relevant, game-changing and affordable,"* concludes Annetts.

Earn CPD Credits

Power Generation From Coal



Coal is the world's most abundant and widely distributed fossil fuel with reserves for all types of coal estimated to be about 990 billion tonnes, enough for 150 years at current consumption.

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Coal fuels 42% of global electricity production, and is likely to remain a key component of the fuel mix for power generation to meet electricity demand, especially the growing demand in developing countries. To maximise the utility of coal use in power generation, plant efficiency is an important performance parameter. Efficiency improvements have several benefits:

- prolonging the life of coal reserves and resources by reducing consumption;
- reducing emissions of carbon dioxide (CO_2) and conventional pollutants;
- increasing the power output from a given size of unit; and
- potentially reducing operating costs.

The calculation of coal-fired power plant efficiency is not as simple as it may seem. Plant efficiency values from different plants in different regions are often calculated and expressed on different bases, and using different assumptions. There is no definitive methodology.

OBJECTIVE

Measuring coal-fired power plant efficiency consistently is particularly important at the global level, yet significant regional differences exist. Similarly, at the local level, the performance of individual generating units and power plants can only be compared if measured consistently.

Although variations in efficiency may arise from differences in plant design and maintenance practices, the practical and operational constraints associated with different fuel sources, local ambient conditions and electricity dispatch all play significant roles. Misunderstanding these factors can result in the misinterpretation of efficiency data.

Thus, reconciling different efficiency measurement methodologies is not simply concerned with theoretical design efficiency, but with the actual operational efficiency of existing power plants and all the associated issues and constraints found in the real world.

This study proposes a generic methodology which can be applied to determine the efficiency and specific CO_2 emissions of coal-fired power generation processes. The application of such a reference methodology would provide a potential route to gauge how coal might be deployed more cleanly and efficiently in the future. To this end, the major objective of this report is to review the methods used to calculate and express coal-fired power plant efficiency and CO_2 emissions, and determine whether these can be reconciled for comparison using a common basis.

FACTORS INFLUENCING POWER PLANT EFFICIENCY AND EMISSIONS

The section reviews the relevance of current power plant performance measurement standards and how these might be reconciled using a common methodology to allow performance benchmarking. The section continues with a summary of the reporting bases and the required information sources for calculating the efficiency of a whole plant according to national standards. CO_2 emissions from fossil fuel use are closely related to plant efficiency and the section concludes with a review of how these are monitored and reported in practice.

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DIFFERENCES IN REPORTED EFFICIENCY VALUES

Apparent Efficiency Differences

Differences in reported efficiencies between plants can sometimes be artificial, and not reflective of any underlying differences in their actual efficiencies. The reported efficiency of two identical plants, or even the same plant tested twice, could potentially be different owing to:

- the use of different assessment procedures and standards;
- the use of different plant boundaries and boundary conditions;
- the implementation of different assumptions or agreed values within the scope of a test standard;
- the use of different operating conditions during tests;
- the use of correction factors to normalise test results before reporting;
- the expression of results on different bases (e.g. gross or net inputs and outputs);
- different methods and reference temperatures for determination of Fuel Calorific Value (CV);
- the application of measurement tolerances to the reported figures;
- differences in the duration of assessments;
- differences in the timing of assessments within the normal repair and maintenance cycle;
- errors in measurement, data collection and processing; and
- random performance and measurement effects.

These effects are difficult to quantify, especially when assessing the performance of major sub-systems that are interconnected with other parts of the plant.

Gross and net values

Assessments of efficiency often refer to "gross" or "net" bases, both for the determination of the heating values of fuel inputs and for the energy outputs from a process. In the latter case, the terminology usually relates to the use of a proportion of the output energy by the process itself: the output being referred to as "gross output" before any deduction, or "net output" after the deduction for own-use. This most commonly applies to the consumption of electrical power by a plant where "generated" power is referred to as "gross output", and "sent-out" power, following deduction of on-site power use, is referred to as "net output" or "gross-net". This analysis can be complicated further for multi-unit sites where some parts of the process may be fed directly from a common import power supply, shared between all generating units. This power must also be deducted from generated power to derive a true "net output" for the plant; an output that may be referred to as "gross-net-net" or "station net export".

For fuels, the difference between Gross Calorific Value (GCV) and Net Calorific Value (NCV) stems from the assumptions made about the availability of the energy present in the moisture in the combustion products.

The GCV measures all the heat released from fuel combustion, with the products being cooled back to the temperature of the original sample. In the NCV assessment, it is assumed that water in the combustion products is not condensed, so latent heat is not recovered. Using the NCV basis is questionable: a modern condensing boiler could potentially achieve a heating efficiency in excess of 100%, in violation of the first law of thermodynamics. Although some regions and industries prefer to use lower heating values in daily business, the true energy content of a fuel is its GCV or higher heating value. Another complication, associated with fuel heating values, is the reference temperature used for their determination. Typically, calorific values are quoted based on a 25 °C reference temperature; however, 15 °C is also commonly used and other temperatures may be used after correction, if these differ from the temperature of the reactants and products at the start and end of the combustion test.

Obviously, the use of values calculated on different reference temperature bases would result in different apparent heat inputs. Some technical standards provide equations for the correction of calorific values between different reference temperatures.

Electrical power imports and exports

Electricity produced and consumed within the plant should not affect plant performance assessment, providing the system boundary is drawn at the outer plant boundary. Electrical power imported into the plant can be deducted directly from exported power in order to calculate the overall net power generation for efficiency assessment. In general, it is recognised that power exports should be referenced to the conditions at the transmission side of the generator transformer and thus account for transformer losses.

Efficiency Differences Due To Real Constraints

It is reasonable to expect that there will be differences in efficiency between particular plants because of the constraints

within which they were constructed and operate. Considerations, which can impact significantly on efficiency, include:

- fuel moisture content (influences latent and sensible heat losses);
- fuel ash content (impacts on heat transfer and auxiliary plant load);
- fuel sulphur content (sets design limits on boiler flue gas discharge temperature);
- use of closed-circuit, once-through or coastal cooling-water systems (determines cooling-water temperature);
- normal ambient air temperature and humidity;
- use of flue gas cleaning technologies, e.g. selective catalytic reduction (SCR), fabric filtration, fuel gas desulphurisation (FGD) and CO_2 capture (all increase on-site power demand); and
- use of low-NOx combustion systems (requires excess combustion air and increases unburned carbon).

A plant designed for high-moisture, high-ash coal, fitted with FGD and bag filters, and operating with a closed-circuit cooling system, for example, could not be expected to achieve the same efficiency as one without FGD using high-rank, low-ash, low-moisture bituminous coal at a coastal site with cold seawater cooling. In most cases, there is little that can be done to mitigate these effects; it is sufficient to recognise that their impact is not necessarily a result of ineffective design or operation, but merely a function of real plant design constraints.

It might be argued that the major fuel factors – the first three bullet points above – are not genuine constraints since, in many cases, fuels can be switched, blended or dried. The commercial feasibility of doing this will depend partly on the availability of fuels and partly on the cost and practicality of purchasing and transporting these to the plant. Coastal power plants may have more fuel supply alternatives than inland power plants close to local coal resources. Another obvious consideration is the environmental impact of transporting fuel over longer distances.

Efficiency Differences In Operation

Efficiency is significantly affected when plants operate under off-design conditions, particularly part-load operation.

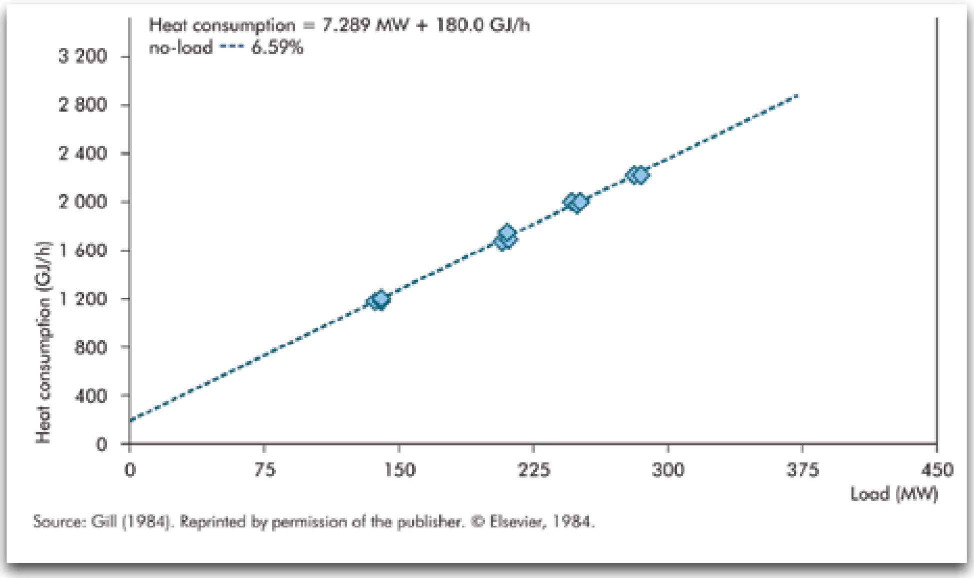
Average operating load

Plants, which operate with a low average output, will return low efficiencies compared to their full-load design efficiency. Steam turbine heat consumption is characterised by a relationship known as the "Willans line", shown in Figure 1 for an example turbine. This line shows that total heat consumption comprises a fixed element and an incremental element: at zero load, the heat consumption is not zero. This relationship is normally derived by undertaking a number of heat consumption tests on a turbine at different loads and then plotting a best-fit line through the observed values.

The overall energy consumption of a plant can be similarly characterised by a fixed element and a variable element proportional to output. Hence, overall efficiency will decline as load is reduced and the no-load portion becomes a greater fraction of the total heat.

Another related consideration is that works power will account for a greater percentage of generated power at part load, because the no-load running losses of electrical equipment increase relative to useful output and because certain activities must be carried out, irrespective of unit load.

For these reasons, power plants may formally record "part-load loss" as a penalty incurred purely as a result of being asked to operate the plant at a lower-than-optimum output.



Source: Gill (1984). Reprinted by permission of the publisher. © Elsevier, 1984.

Figure 1: Typical relationship between steam turbine heat consumption and operating load

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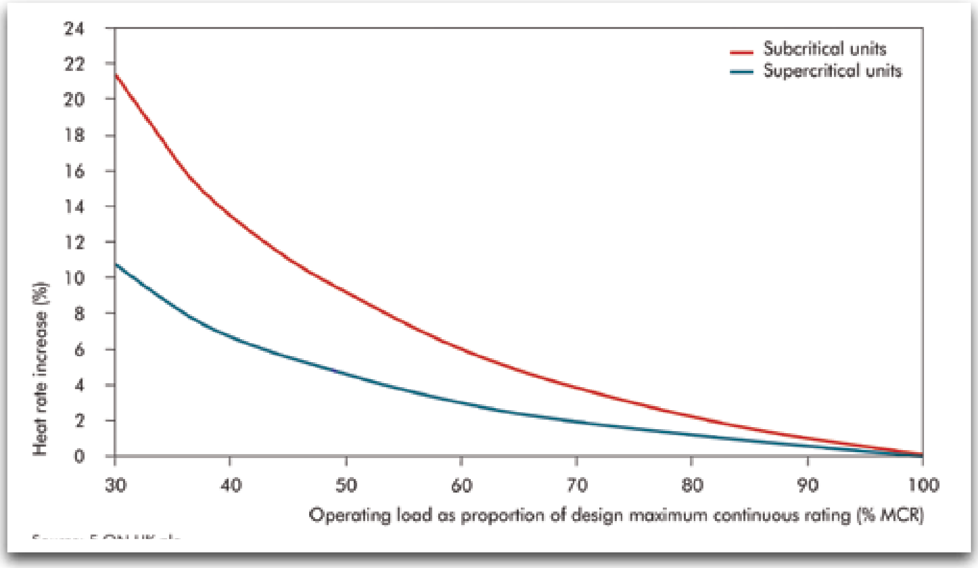

Figure 2: impact of unit operating load on heat rate

Figure 2 derived from the Willans line and assuming an overall unit fixed heat rate of 9% (i.e. greater than the turbine-only fixed heat rate), illustrates the effect of running at lower loads on the performance of subcritical and supercritical units. Supercritical units are shown to experience only about half the part-load efficiency degradation of a conventional subcritical unit.

Load factor

The effects of average operating load (see above) and load factor are different. Load or capacity factor describes the output over a period of time relative to the potential maximum; it depends on both running time and average operating load. It is not necessary to consider load factor specifically here since the impacts of more frequent unit starts or lower operating unit loads can be taken into account separately. It is technically possible for a low load factor plant to attain high efficiency if starts are few in number and the load is kept high during the periods of generation. However, there may be practical issues relating to system power demand and management, which preclude operation in this way.

Transient operation

Another factor, which can significantly impact efficiency, is the number of perturbations (transients) from steady state operating conditions. During each of these transients, the plant will not be operating at peak performance: the more transients, the greater the reduction in efficiency. Operation in frequency response mode, where steam flow and boiler firing fluctuate to regulate system frequency, can lead to more transients. Other situations may require frequent load changes, notably in response to power system constraints or power market pricing.

Plant starts

An extreme form of transient operation is where demand falls sufficiently to require plant shutdown. This incurs significant off-load energy losses, particularly during subsequent plant start-up, which must be done gradually to avoid damage from thermal stresses. While the plant is not generating output, all of the input energy is lost (i.e. efficiency is 0%). Supercritical units, in particular, have high start-up losses because large quantities of steam, and therefore heat energy, must be dumped to the condenser during start-up.

Power plants operating in volatile or competitive markets, or operating as marginal providers of power, may be required to shut down frequently. This can, in turn, lead to a deterioration in physical condition which will affect plant efficiency. For base-load operation, unit start-up energy may be a negligible fraction of total energy (<0.5%). For other flexibly operated plant it could represent 5% or more of total energy consumed and result in reductions in efficiency in the order of 2 percentage points, even if the average output during the on-load period is high. For simplicity, corrections of 0.5%, 1.5% and 5% of total energy use could be applied to plant running regimes categorised as "base-load", "transitional" and "marginal/peaking".

Performance optimisation

The adoption of good practices and exercise of care will avoid most operational problems within the control of a plant operator. Although the majority of operational efficiency variations are linked to unit load and the need to operate through transient conditions, there is usually some scope for final optimisation of performance by fine tuning of automatic controller set points and control loops, amounting to about 1% of a unit's heat rate. Optimisation may be performed manually or through the use of advanced control systems or optimisers, some of which are based on neural networks. Operator experience can also be a source of operational gains or losses. The commercial attractiveness of performance

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optimisation increases with plant load and can be substantial at high loads. Optimisation is a potentially attractive proposition at any load where the plant will be operated for a significant period of time.

Boiler operation is an area where efficiency gains are often possible. A "fixed-pressure" boiler requires the outlet steam to be throttled at part load to match the lower pressure demand of the turbine. "Sliding-pressure" boiler designs avoid this loss, with the added benefit that feed-water pumps require less power. Sliding-pressure control is standard operating procedure on most modern power plants.

Control systems play a major part in optimisation by enabling the automation of best practices. The use of advanced control systems can bring about significant efficiency improvements and reduce CO_2 emissions.

Regulation

The regulatory environment can have a significant impact on power plant operation and efficiency. Meeting the requirements of environmental emissions legislation, even where flexible with respect to operating regime and fuel quality, can be a challenge to operators. In some cases, achieving multiple objectives simultaneously can impact efficiency since transients, off-design fuels and emission controls generally add to energy losses. Functional performance, for example to achieve target output, load ramp rates or frequency control, may be a higher priority to the plant operator than efficiency optimisation. Where a plant operates within a competitive market environment, making the case for investment in plant maintenance and upgrades to improve performance and efficiency may be more difficult because operating margins may be slim, and market volatility may hinder long-term investment planning.

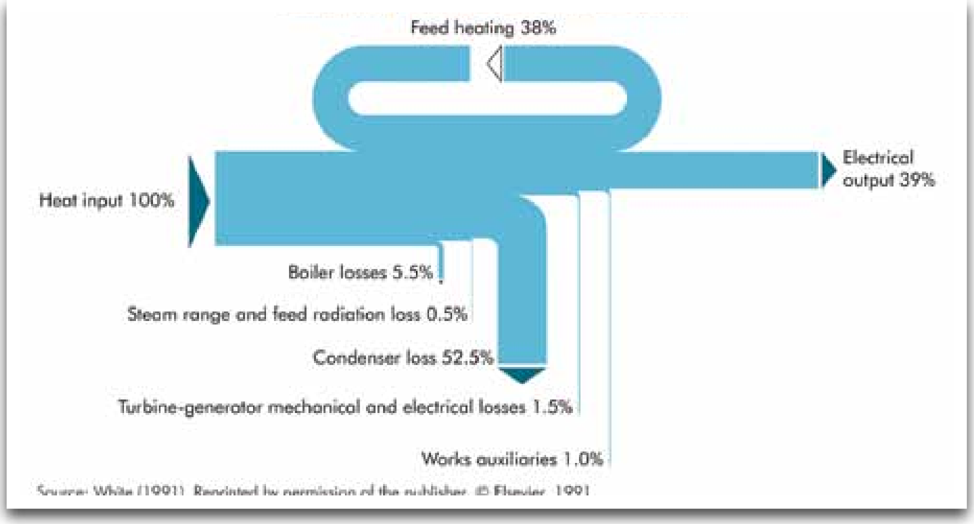

Figure 3: example energy flows in a typical 500 Mw subcritical pulverised coal-fired boiler

Energy And Efficiency Losses

The transfer of heat energy to the working fluid of the power cycle can never be complete or perfect. The presence of tube wall and refractory material (if used), surface deposits and non-ideal flow regimes all impede heat transfer. In the case of a coal-fired boiler, the net result of these imperfect conditions is a degree of heat loss from the hot source (burning coal) in the form of hot flue gases. In cases where condensation has to be avoided, and particularly where the acid dew point temperature is raised because of the presence of sulphur, chlorine or excessive moisture in the fuel, the hot flue gases loss can be significant. Auxiliary equipment consumes energy, e.g. coal mills, water pumps, fans and soot blowers for cleaning heat transfer surfaces. Some heat is also lost to the surroundings through conduction, convection and radiation of heat, even where equipment is insulated. The turbo-alternator plant similarly has losses, which reduce performance compared to the ideal, and although efforts are made to minimise these, there are economic and practical limits to what can be achieved.

In summary, the plant will have losses associated with:

- combustor flue gas wet and dry gas losses and unburned gas heating value;
- combustor solid residue sensible heat content and unburned fuel heating value;
- heated water or steam venting and leaks, and other drainage and blow-down;
- frictional losses, radiated and convected heat;
- cooling system losses where heat is rejected and not recovered;
- heat lost to flue gas treatment reagents and energy consumed by fans in overcoming gas pressure drops;
- make-up and purge water;
- off-load losses associated with start-up and shutdown;
- off-design losses associated with transient operation and part-load running; and
- transformer losses.

IMPACT OF CONDENSER-OPERATING CONDITIONS ON EFFICIENCY

The Sankey diagram in Figure 3 shows example heat flows in a typical 500 MW subcritical pulverised coal-fired boiler, where the electrical output is 39% of the heat input and the heat rejected by the condenser to the cooling water is 52.5%. This example illustrates that it is the thermodynamics of the steam cycle, and not the fuel combustion process, which is a limiting factor for conventional power plant efficiency. Where the rejected heat can be utilised, this can provide significant improvements to the overall cycle efficiency.

A relatively small change in condenser pressure, in the order of thousandths of a bar (or hundreds of pascals), can bring about seemingly disproportionately large changes in plant efficiency. To achieve similar changes in efficiency at the high-temperature end of the cycle would require more significant changes in steam conditions. A major factor governing the condenser pressure is the availability of a cold heat sink for heat rejection. This is often provided in the form of a large body of water such as the sea or a river, although heat can also be rejected using closed-circuit wet, semi-dry or dry cooling systems. The temperature and quantity of cooling medium available to the condenser have a significant impact on performance.

Since economics generally determine the heat exchanger size, and the capacity of the cooling system, a major factor determining real plant performance becomes the cooling-water supply temperature to the condenser. This tends to be lowest for coastal sites in the northern hemisphere and highest for sites in locations with high ambient temperatures and limited water supplies.

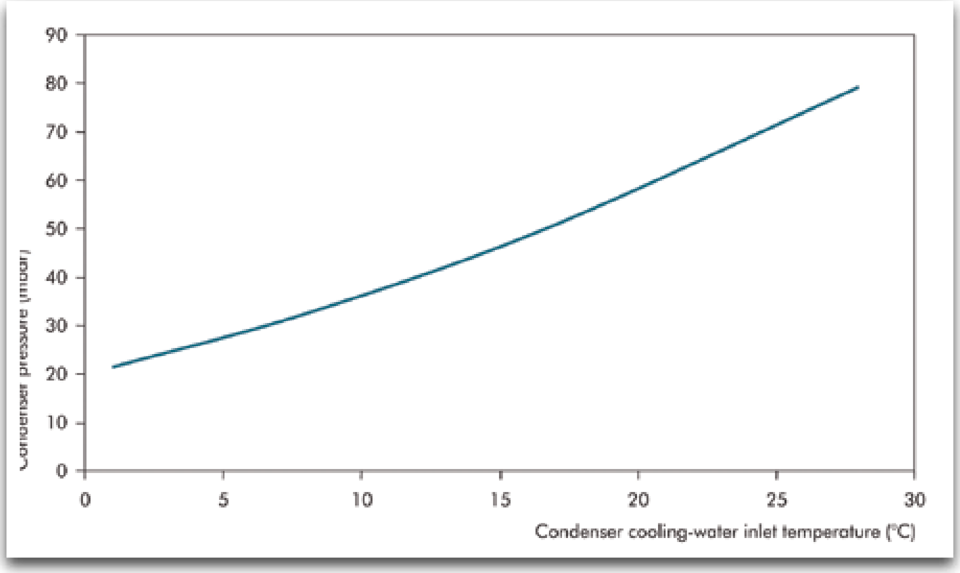

Figure 4: example of the impact of cooling-water temperature on condenser pressure for constant unit load

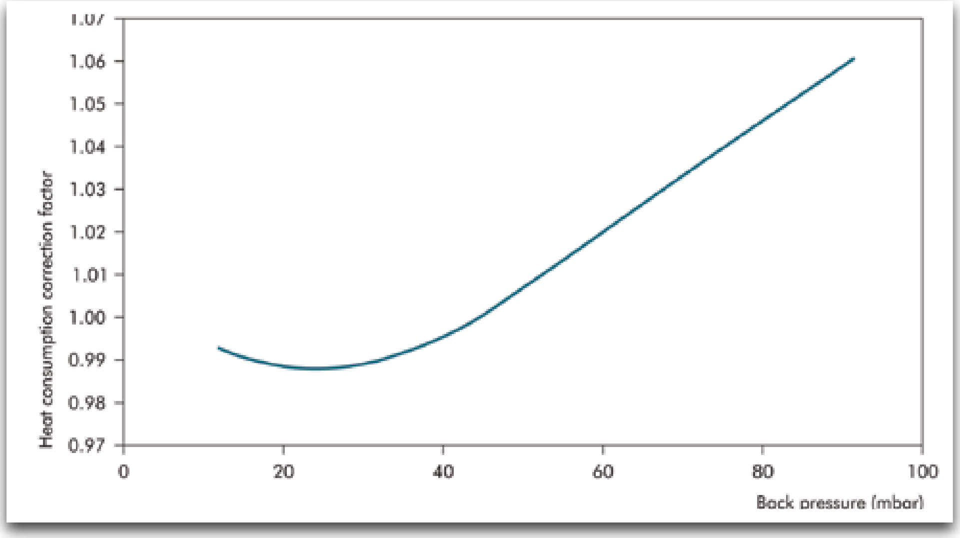

Figure 5: Impact of condenser pressure on heat consumption

The precise impacts of cooling-water temperature on condenser pressure, and the associated impact of condenser pressure on heat rate, are site-specific. Like many of the other losses considered in this report, a detailed thermodynamic model in conjunction with real plant operating experience should be used to assess site-specific losses. However, within reasonable limits, some approximations can be made. In general, the impact of cooling-water temperature on condenser pressure is about 2 mbar per 1 °C change in inlet temperature, and the associated impact on heat rate is in the order of 0.1% of station heat consumption per 1 mbar. Thus a difference of 5 °C in cooling water inlet temperature might change unit heat consumption by around 1%.

Ambient conditions change both seasonally and diurnally. In the case of a

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closed-circuit cooling system, there will be feedback effects from the load on other units, which may be using the same cooling system. These all affect heat consumption. Examples of the impact of cooling-water temperature on condenser pressure and the impact of condenser pressure on heat consumption in conventional steam plants are shown in Figures 4 and 5.

Maintaining a low condenser pressure is clearly important. However, power plant condensers tend to suffer from degradation in performance over time because of scaling and fouling, as well as any loss of area due to the removal from service of damaged elements (usually by sealing). Although periodic physical cleaning is usually performed, and some stations have on-load cleaning systems, performance still varies according to the state of cleanliness. Figure 6 illustrates the effect of condenser cleanliness on heat consumption.

Steam cycle efficiency can be improved by extending the working temperature range through the addition of "topping" or "bottoming" cycles. In the topping cycle, a gas turbine is employed, where the working fluid is hot gases at a higher temperature than steam in a steam turbine, and exhaust heat is used in the boiler of a Rankine steam cycle. In a bottoming cycle, refrigerant-type fluids can be used to accept the heat rejected from the Rankine cycle and do more work in a separate turbine or expander designed for the lower temperature gas. Neither option is commonly employed in coal-fired electricity generating plant, although a combined cycle gas turbine plant is effectively a topping cycle with a Rankine cycle, albeit with no direct firing of the heat recovery boiler.

HEAT AND POWER EQUIVALENCE

Both heat and electrical power are forms of energy and can therefore be measured using the same engineering units. Energy conversion processes themselves can only convert heat into power with certain efficiency; losses mean that electric power requires more primary energy than heat, making electricity more valuable. Although net power and net heat outputs can be calculated separately, the equivalence between power and heat requires careful consideration. Heat use, in particular, can be a very important factor in efficient coal energy utilisation and specific CO_2 emissions.

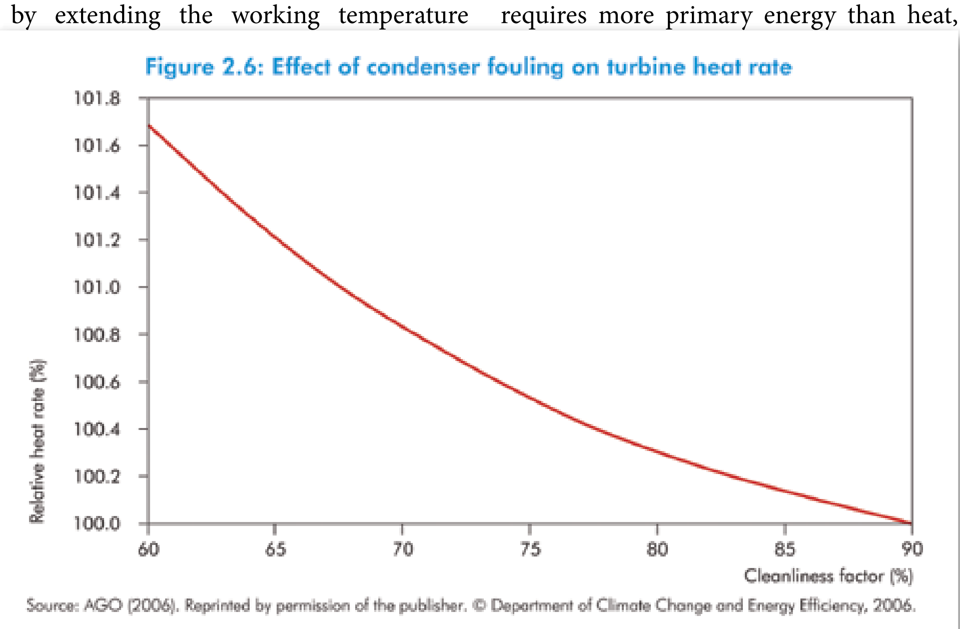

Figure 6: effect of condenser fouling on turbine heat rate

Plants supplying both heat and power have an overall plant energy efficiency that can be calculated by taking into account both the heat and power outputs from the process. While it is also possible to calculate effective efficiencies for heat and power production independently, these values may have less meaning and require more interpretation. For example, the heat output can be used as a fuel heat rate correction to yield a net heat flow used for electricity generation.

In the case of a power production process where rejected heat is not utilised, as in most utility-scale plants, the total fuel energy input is used to produce electrical power with a given efficiency. If the waste heat was recovered and used, it could be argued that the heat was not produced specifically to meet demand, the efficiency of its production might be considered to be 100%. The use of some of this otherwise waste heat now brings about an apparent increase in plant electrical efficiency, even though nothing in the basic power production process has changed. If, however, the waste heat utilisation were excluded from the power generation efficiency, then this would not reflect the energy efficiency benefits of combined heat and power.

Some standards and protocols suggest that heat and power generation efficiencies should be calculated separately and each

referred to the total energy input (usually input fuel energy, but may also include power and heat energy from other sources) as follows:

$$\text{power generation efficiency} = \frac{\text{output power energy}}{\text{total energy input}}$$

$$\text{heat generation efficiency} = \frac{\text{output heat energy}}{\text{total energy input}}$$

This provides one method of determining efficiency, although the results may be misleading. If some or all of the rejected heat from power generation is used to satisfy a heat demand, and therefore offset other energy use, this is not recognised in the power generation efficiency calculation. It is proposed that heat rejected from the steam cycle which is recovered and put to use is not considered as consumed by the power process, or treated as a loss, but is instead treated as energy supplied to the heat system.

The overall energy efficiency of the plant can then take account of power and heat export, as applicable:

$$\text{plant efficiency} = \frac{(\text{output power energy} + \text{output heat energy})}{\text{total energy input}}$$

The apparent electrical efficiency can be determined by debiting any heat energy output from the total input energy. In other words, any useful energy output, other than electricity, effectively reduces the energy attributed to the generation process. For example, consider a plant with a fuel energy input of 500 GJ producing power with an energy equivalent of 200 GJ (56 MWh). The overall plant efficiency equals the power generation efficiency, because there is no heat output:

$$\text{power generation efficiency} = \frac{200}{500} = 40.0\%$$

If 150 GJ of the waste heat is used, then the overall plant efficiency increases:

$$\text{overall plant efficiency} = \frac{200 + 150}{500} = 70.0\%$$

The apparent electrical or power generation efficiency is now:

$$\text{power generation efficiency} = \frac{200}{500 - 150} = 57.1\%$$

Similar analysis can be used to calculate the efficiency of heat production:

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$$\text{heat generation efficiency} = \frac{150}{500 - 200} = 50.0\%$$

This method of analysis, although not perfect, is a practical means of calculating and comparing real plant efficiencies. In the above example, the heat generation efficiency is low compared to the efficiency of a modern heating boiler. However, the use of waste heat improves the effective efficiency of the power generation process and the overall energy efficiency. It should be noted that the overall efficiency is not the simple numerical sum of the power and heat efficiencies.

The simplicity of this calculation enables the output heat energy to be used directly as a correction factor to the overall efficiency figure of a combined heat and power plant. Figure 7 shows a generic correction factor, which can provide corrections for a range of plant types. It should not be used to determine or correct the independent heat-only or power-only efficiencies.

A more complex relationship and a set of power loss coefficients are described in the German VDI 3986 standard (VDI, 2000). However, this degree of complexity is rarely necessary. The VDI also calls for the heat energy to be expressed in terms of the electrical power which it would have generated had it been used in the main power process. The ASME PTC 46-1996 performance test code, from the United States, permits corrections for exported heat, although these corrections are based on modeling analysis for particular scenarios (ASME, 1997).

In a refinement to the analysis described above, European Union law requires that the heat supply be grossed up to the input energy that would have been needed to supply the same heat from a stand-alone heating boiler operating at 88% efficiency (or 86% in the case of lignite-fired plants). The power generation efficiency in the above example then becomes:

$$\text{power generation efficiency} = \frac{200}{500 - 150 / 0.88} = 60.7\%$$

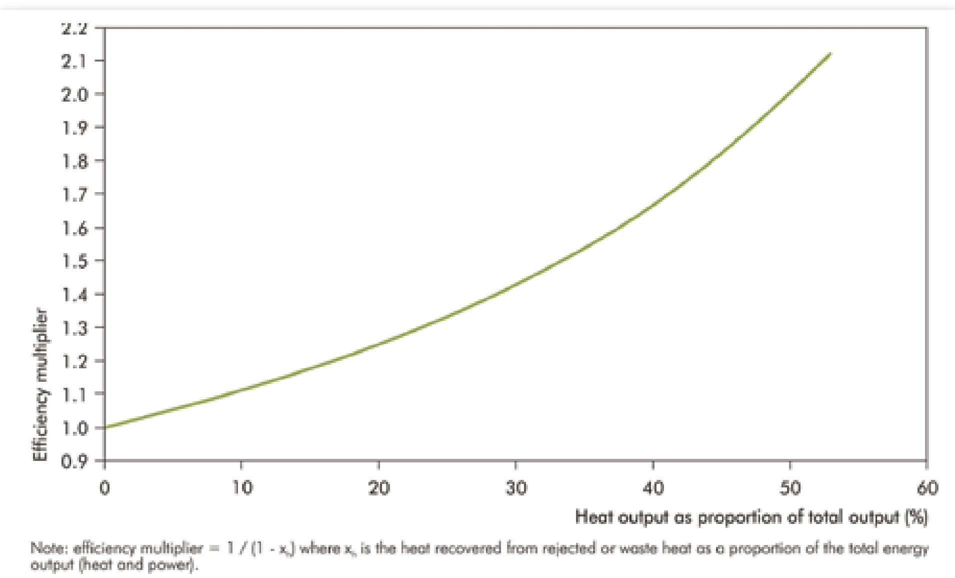

Figure 7: Effect of heat supply on overall efficiency

EFFICIENCY PERFORMANCE ASSESSMENT PERIODS

Most generation assets, whether operated for power, heat or both, have varying capacity, load or utilisation factors. Their outputs may change depending on the time of day, season, and state of the energy market or demand profiles. These changes affect performance since plants must operate under off-design conditions (e.g. transients or part-load) or face energy penalties associated with, for example, unit start-ups and shutdowns. Attempting to represent a given plant with a single performance figure is therefore almost meaningless when taken out of temporal context, even before the detail of the calculation is considered. Unfortunately, this is not often recognised in comparisons of technologies, and misleading conclusions can easily be drawn.

Potential bases upon which performance could reasonably be stated include:

- theoretical maximum;
- as-designed;
- as-commissioned;
- best-achieved;
- latest or best-recent;
- average-daily;
- average-weekly;
- average-monthly;
- average-annual;
- average inter-overhaul; and
- average cumulative-to-date.

As can be seen, the conditions of the tests may or may not be at the maximum rated output; and may or may not be carried out at, or corrected to, a set of standard reference conditions, including ambient temperature and pressure, and cooling-water temperature. Although tests at the rated output demonstrate the potential

performance of the plant, the actual average performance may be significantly lower for the reasons discussed above.

The assessment of overall plant performance needs to establish not just what the plant was designed to, or might achieve, but what it actually does achieve under real operating conditions. It is this measure which ultimately determines the energy use of the plant and its related CO_2 emissions. Although reference to a standard set of conditions might sometimes assist in the technical comparison of plants, it would generally be preferable to use the actual conditions for comparison rather than an arbitrary set of reference conditions.

Most power plants operating within a regulated environment will be required to submit annual reports and data returns from which the main information for whole plant performance assessment should be available. The advantage of adopting an annual operating period is that, irrespective of start and end dates, it will tend to smooth out many of the potentially variable factors such as ambient conditions, seasonal variations, operating regime, short-term plant problems and fuel quality to provide more confidence in the assessment. Assessments based on short-term tests will generally be over-optimistic and exclude many factors, which degrade performance during normal commercial operation.

The accuracy of annual performance figures is generally good provided that they are generated within a reasonably well-controlled regime. For example, fuel deliveries should be made over calibrated weighbridges and subject to CV and analysis checks, power and heat exports and imports should be measured with calibrated metering devices, and on-site stock adjustments should be taken into account. The overall accuracy of performance calculations should then be within ±2% of the actual energy consumption (or better than ±1% if calibrated belt weighers are used) for a well-managed plant, or within ±5% for a poorly managed installation.

The problem with annual reporting is that it does not necessarily reflect the best potential performance, which is possible from the plant under favourable conditions.

For this reason, it is suggested that for reference, and where available, the annual performance figure is supplemented by an additional assessment based on short-term formal test data at close to rated output conditions, which should represent the best achieved performance of the unit under the prevailing test conditions. Although such tests could be done in accordance with PTC 46-1996 (ASME, 1997), it is more likely that the boiler and turbo-alternator would be tested separately and the figures combined with suitable corrections for other losses.

EFFICIENCY STANDARDS AND MONITORING

Fired boiler performance standards

There are a number of standards for the performance assessment of coal-fired power plant boilers including:

- BS 2885:1974 (withdrawn British standard);
- DIN 1942 (German standard);
- EN 12952-15:2003 (European standard, similar to DIN 1942).
- PTC 4-1998 (current US standard); and
- PTC 4.1-1964 (1991) (former US standard, superseded by PTC 4-1998).

There are a number of major drawbacks related to the use of these standards.

- The standards are inconsistent and therefore results based on one standard cannot be compared directly with those based on another standard without considerable care.
- They permit a wide range of system boundaries, exceptions and amendments to be made by agreement between parties to the test. This means that, even though two tests may have been undertaken in compliance with the same standard on the same plant, the results may not be comparable. Furthermore, tests on different plants are unlikely to be directly comparable. Clarification of the detailed basis on which a test result has been calculated requires more information than would be reasonable for the purposes of generating overview comparisons of plant performance.
- These test codes focus on the assessment of the boiler which, although very important, is only one component of a coal-fired power plant. While the boiler energy conversion efficiency is an important consideration, the turbo-generator and balance-of-plant equipment have a major bearing on the overall plant performance.
- It would be impractical to apply these standards during normal plant operation because they specify certain test conditions. Similarly, the efficiency obtained under test conditions will not be representative of normal operation.

The main purpose of boiler performance test codes is to provide a contractually binding means of assessing the performance of new, modified or refurbished plant on handover. As such, the standards are a means to an end and act as a convenient and widely

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accepted measure which can be used with minimal modification for establishing a plant performance benchmark, even if this is not representative of future plant performance. For the reasons outlined above, boiler performance standards are not suitable for the comparison of overall power plant performance.

REPORTING BASES FOR WHOLE PLANT EFFICIENCY

In most regions of the world, efficiency is expressed on the basis of the fuel's Gross Calorific Value (GCV) and net electrical power output. This appears reasonable for the purposes of comparison since it reflects the total energy input and useful electricity output. However, other bases are also used. In Europe, for example, it is common to express efficiency on a Net Calorific Value (NCV) and net power output basis, reflecting the difficulty of recovering latent heat and coal trade on a net calorific value basis.

Where there are multiple units on a power station site, the "station" consumption for common services is generally not included in the efficiency determination of individual units; even for unit-based calculations, the plant boundaries, test standards and efficiency calculations can vary significantly. In most cases, unless otherwise stated, efficiencies are quoted for convenience on the basis of design, acceptance or expected maximum output efficiencies, and are generally not representative of those achieved in practice.

CO_2 EMISSIONS REPORTING

The EU Emissions Trading Scheme (ETS) is the largest greenhouse-gas emissions trading scheme of its kind in the world. At present, the scheme requires the annual reporting of CO_2 emissions by mass, similar to routine measurement and reporting undertaken in countries such as the United States. Specific emissions reporting per unit of production (e.g. gCO_2/kWh) is not required. Emission calculations are based on fuel used and agreed oxidation factors. Reporting of figures on the basis of actual oxidation factors, rather than the assumed values, is permitted where actual values are available and can be verified.

Greenhouse Gases And Life-Cycle Assessment

This section focuses on energy efficiency and CO_2 emissions at coal-fired power plants during fuel conversion into useful output energy. The purpose of clarifying whole plant efficiency and emissions reporting methodologies is to provide a relatively simple, common basis for relative performance assessment.

Emissions of methane, CO_2 and other greenhouse gases associated with the extraction, preparation and delivery of fuel to power plants are not considered. Similarly, the greenhouse-gas emissions associated with the construction of coal-using plants are not taken into account in this operational assessment, although they might be considered as part of a more detailed life-cycle analysis, for example as part an environmental impact assessment for a new plant.

There are a number of published studies on methane production from mining and the carbon cost of transporting bulk commodities from which generic relationships could be created to estimate the Green House Gas (GHG) emissions footprint of coals sourced from different mines and transported over different distances using different modes of transport.

Co_2 Reporting Issues

Carbon or CO_2

Most reporting systems in use around the world report on the basis of CO_2 emissions and use factors to report other greenhouse-gas emissions as their CO_2 equivalent (CO_2e). Occasionally, CO_2 emissions are quoted in terms of carbon (C), or confusingly are stated as "carbon" when they are in fact CO_2. The equivalence in mass terms between carbon dioxide and carbon is simply the ratio of their molecular masses CO_2:C, this being 3.6632 (IUPAC, 2005).

Input versus output basis

Input-based emission calculations and limits for the mass of CO_2 emitted per unit of input energy, expressed in units such as tCO_2/GJ or lb/MMBtu coal, create a poor comparison of specific emission rates. They imply that producing the same total emissions from the same quantity of fuel represents equivalent performance. In reality, although a more efficient plant consuming the same mass of fuel as a less efficient plant creates the same total quantity of CO_2, it does so with the benefit of producing more useful output energy. Emission standards based on useful energy output (e.g. tCO_2/GWh) are therefore important, since they recognise the benefits of higher efficiency and incentivise the development and implementation of cleaner, more efficient technologies.

Mass versus volume basis

Reporting gaseous emissions on a volume basis is not straightforward. Quantities must be expressed against a reference

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temperature, pressure, moisture and oxygen concentration if they are to be correctly compared or assessed against emission standards. In contrast, reporting emissions on a mass basis is absolute and avoids any requirement for volumetric corrections. CO2 emissions in mass units, rather than volume units, are therefore preferred and are widely used by most reporting systems and analysts.

Units of output

To report specific CO_2 emissions in terms of a power plant's useful output requires heat and electrical energy to be combined, as for the overall efficiency calculations described above. Common energy units are needed, e.g. gigajoules (GJ) or megawatt hours (MWh), with simple conversion factors between these.

Typically, large subcritical coal-fired utility plants today produce around 900 $kgCO_2$/MWh. This figure becomes higher for high-moisture fuels, or for plants operated at low load factor or of inferior design. This can be compared to around 740 $kgCO_2$/MWh for state-of-the-art modern supercritical plants, and potentially around 600 $kgCO_2$/MWh for plants with advanced steam conditions that are currently under development. Carbon dioxide capture and storage (CCS) offers perhaps the only way to make further reductions in CO_2 emissions from conventional coal-fired plants. CCS would cut emissions to 60-70 $kgCO_2$/MWh, assuming >90% CO_2 capture from future state-of-the-art plants. Potentially, a net emission of zero is possible where the plant also fires a small proportion (approximately 10-15% by heat input) of biomass material to compensate for the residual CO_2 emissions not captured in the plant.

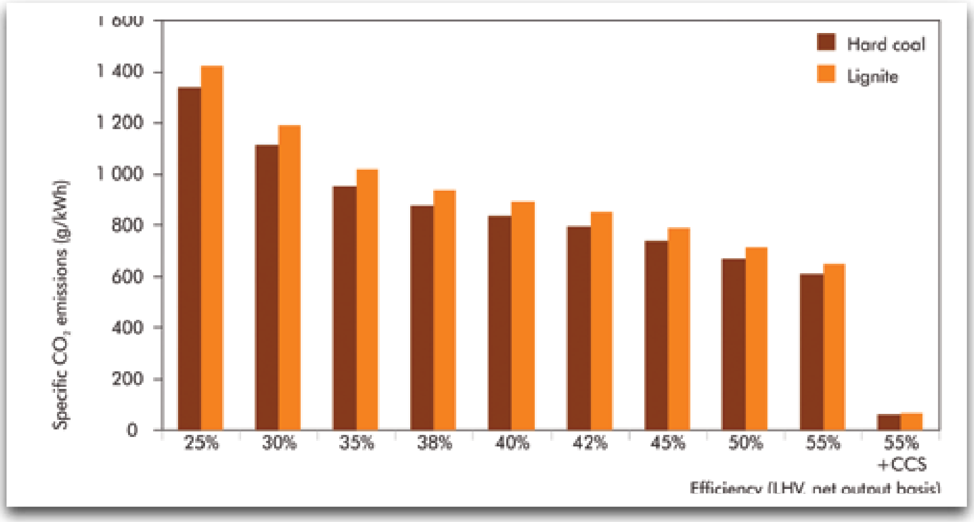

Figure 8: example of relationship between Co_2 emissions and net plant efficiency (with and without CCS)

Determination of Emitted Co_2

Commercial instrumentation is available for monitoring CO_2 concentration and flue gas volume flows. Given the limitations of such instrumentation, the accuracy of directly measured CO_2 release is probably no better than that derived by indirect calculation. Moreover, many plants do not measure flue gas volume flow and CO_2 concentration, so indirect calculation of emitted CO_2 is the only option and can be applied consistently.

Where FGD processes are employed for SO_2 removal, the mass release (M_{FGD}) of carbon from the reaction between limestone ($CaCO_3$) and flue gas should be considered in the plant assessment, although its contribution to total emissions will be relatively small. The release mechanism is:

$$CaCO_3(s) + SO_2(g) + ½O_2(g) + 2H_2O(l) \Rightarrow CaSO_4 \cdot 2H_2O(s) + CO_2(g)$$

The treatment of CO_2 emissions from plant incorporating carbon capture is more difficult since the removal efficiency of the capture plant needs to be included in the calculation. It is likely that a removal efficiency factor (X_{CCS}) of 90% or more would be achieved. The calculation of CO_2 emissions must account for all these additions and reductions, such that the mass release (M_{out}) is:

$$M_{out} = 3.6632 \times (M_{in} + M_{FGD} - M_{ash}) \times (1 - X_{CCS})$$

Where M_{in} is the mass of carbon in the fuel input and M_{ash} is the mass of unburned carbon retained in ash.

The use of further correction factors for CO_2 emissions follows similar principles to those for efficiency calculations. For the purposes of developing a common plant assessment methodology, specific greenhouse- gas emissions analysis is limited only to the CO_2 produced during fuel conversion into useful supplies of energy, including electricity and heat. As with efficiency, proper account must be taken of any heat supplied when calculating specific CO_2 emissions per unit of electricity supplied

GENERIC RECONCILIATION METHODOLOGY

By taking into account the factors presented previously, it is possible to derive a common

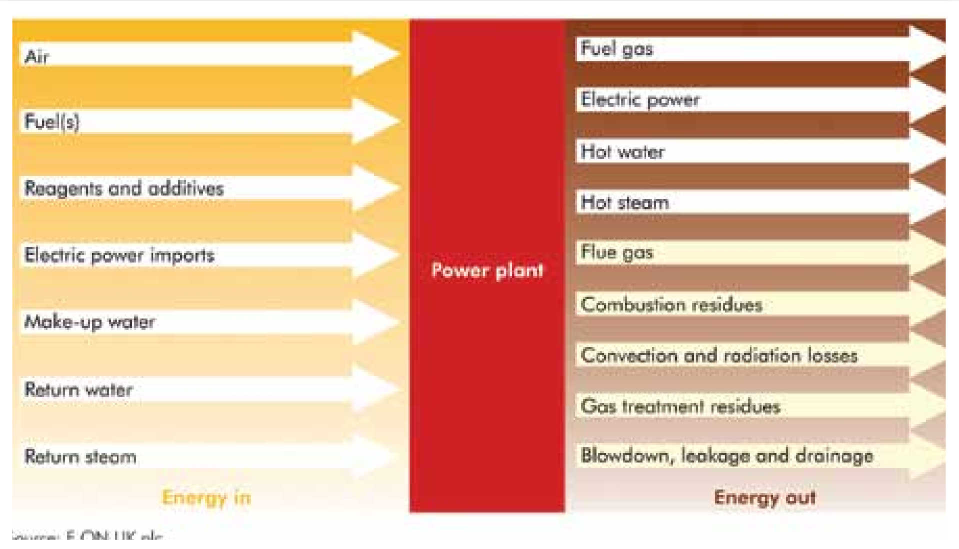

Figure 9: Example of a process boundary showing energy in-flows and out-flows for a power plant

methodology for expressing and comparing whole plant efficiency and specific CO_2 emissions relative to useful energy output for a wide range of different conversion plant types and fuels. For convenience and consistency, it is recommended that units of measurement are in accordance with the ISO 80000-1:2009 standard system (ISO, 2009).

Process boundaries

To avoid the need for performance details of individual plant components, a system boundary should cover the entire power plant, from fuel reception to the interface with the power or heat transmission system. This may or may not coincide with a clear physical boundary, depending on the plant layout and its application.

This approach simplifies the assessment of overall plant performance and can be applied consistently to many plant types and fuels. It also removes any debate regarding how internal energy flows, such as works power or own-use consumption, or water and steam interconnections, should be accounted for.

Such a "black-box" approach to the whole power plant island is shown in Figure 9, in which the energy output associated with the shaded flows can be ignored in the calculation of overall plant efficiency. Although in the short term, the measurement of some of these parameters may be subject to measurement error, the accuracy of data over longer time periods, and particularly annual periods, should be high.

Input data requirements

In order to perform an assessment of power plant performance, plant operators must ensure that they:

- weigh, or obtain weights for, all delivered fuel using calibrated equipment;
- undertake representative sampling and analysis of all fuel supplies to determine the average values of calorific value, moisture content, ash and sulphur;
- meter power import and export using calibrated equipment in order to determine net power export; and
- where applicable, meter and determine the heat content of incoming and outgoing water and steam in order to determine net heat export.

The average annual values of these parameters may then be used to determine plant performance indicators. Where there is more than one unit, such information must be provided on an overall station basis as a minimum, but the provision of supplementary information for individual units could also be required.

Output data

The assessment of the annual performance of a given power plant should be held in a database to facilitate comparison with other data. The final evaluation of plant performance in accordance with the methods described here needs to be captured in a clear and concise format, and must concentrate on the key indicators which are relevant to the creation of the database. Part of the record for each plant needs therefore to comprise the summary output data and part needs to comprise summary descriptive data.

EFFICIENCY OUTLOOK FOR POWER GENERATION FROM COAL

The need for energy, together with the economics of producing and supplying that energy to the end user, are central considerations in power plant investment decisions and operating strategies. Inevitably, there will be a point at which higher efficiency and lower emissions come at a cost which cannot be justified. Where economic and regulatory conditions exist which shift this balance consistently in

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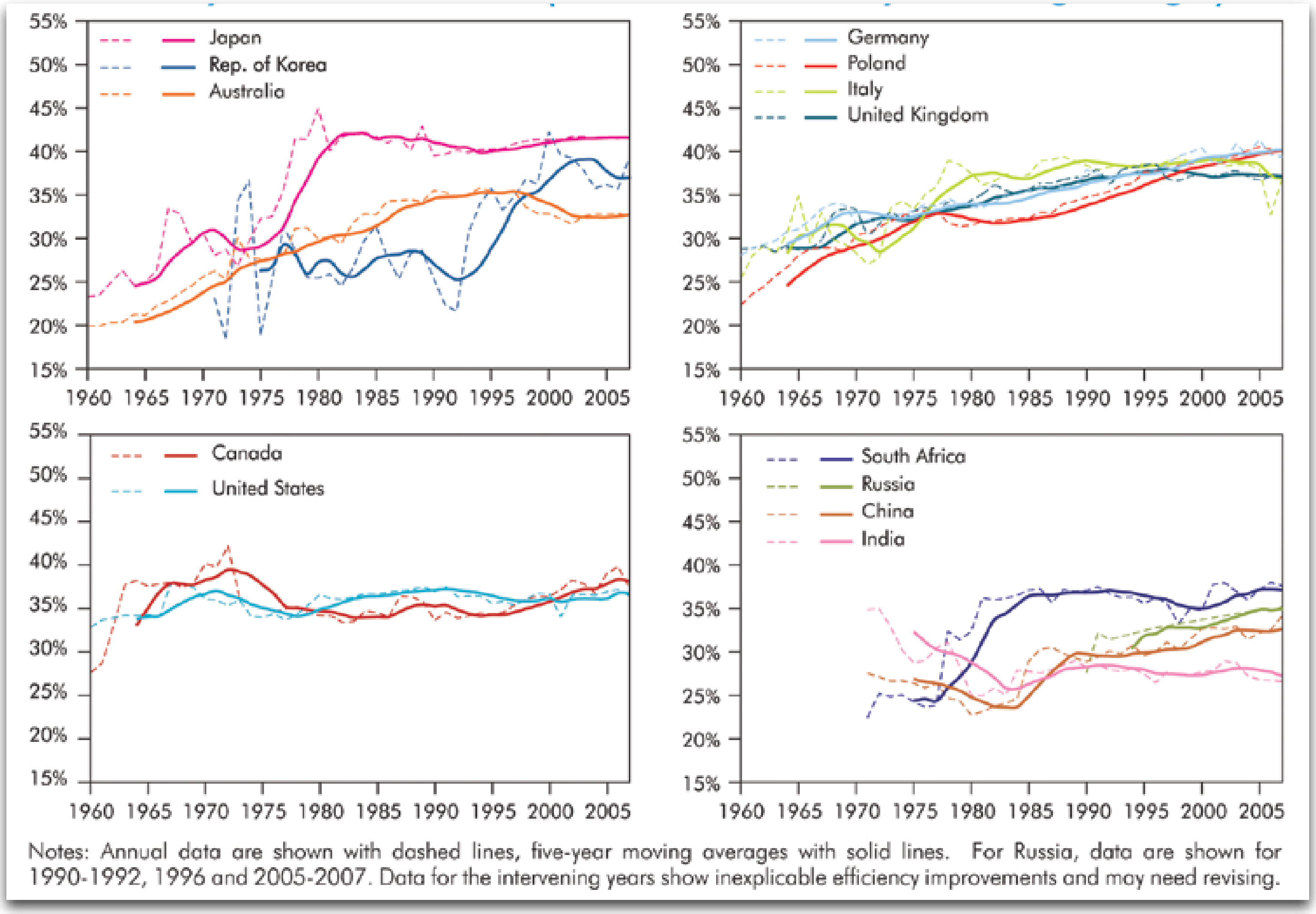

Fig 10, 11, 12 and 13: Evolution of coal-fired heat and power plant efficiency in selected countries (annual data and five-year moving averages)

favour of higher efficiency and lower emissions, improvements become a normal part of running a competitive business. The trend over time has been towards improved power plant performance.

Worldwide coal-fired power plant efficiency averaged 35.1% in 2007, compared with 33.5% in 1971. Figures 10, 11, 12 and 13 illustrate the evolution of efficiency in countries where coal is used widely for electricity generation and heat supply. This top-down assessment is based on annual coal consumption and electricity supply data collected by the IEA. The annual data (dashed lines) are smoothed by using five-year moving averages to show long-term trends (solid lines). Fuel energy input is on a Net Calorific Value (NCV) or Lower Heating Value (LHV) basis, while electricity output is on a gross basis (i.e. at the generator terminals, before any deduction for on-site electricity use), each being the basis adopted by the IEA for reporting energy statistics. Heat supply is based on the quantity of heat supplied under commercial arrangements; the gross- net concept has no meaning for heat supply. Efficiency is calculated after correcting for heat supply using the methodology adopted by the EU. While this assessment allows comparison of coal-fired power generation efficiency at the national level, it does not allow performance comparisons to be made between individual plants; indeed, the IEA does not collect plant-level data.

The development of supercritical and ultra-supercritical steam cycles, with progressively higher steam temperatures and pressures, combined with modern plant design and automation, provide







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significant potential for further efficiency improvements and the mitigation of CO_2 emissions when compared with existing coal-fired power plants. These improvements can be realised through the progressive replacement of existing assets with new plant designs that reflect best practices.

Although a large number of supercritical and ultra-supercritical pulverised coal-fired power plants are currently under construction or planned, subcritical technology has continued to dominate recent build. However, with stricter requirements to limit CO_2 emissions, the share of supercritical and ultra-supercritical plants should increase.

By far the largest energy loss from existing and future coal-fired power plants will remain the heat rejected from the steam cycle to the cooling water. The use of cogeneration or combined heat and power, along with district heating and cooling, has therefore received renewed interest in the light of requirements to improve energy efficiency and reduce specific CO_2 emissions. However, the most significant potential to reduce CO_2 emissions from coal-fired power plants will come through the application of CO_2 capture and storage. Here, basic plant efficiency improvements will be a significant factor in ensuring the viability of carbon capture.

Figure 14 shows projections by VGB for the efficiency of and emissions from coal-fired power generation by 2020. With proper policy and financial support for demonstration, by 2015 the net efficiency of state-of-the-art units firing hard or bituminous coal could reach 50% (LHV, or around 48% HHV) at plants without CO_2 capture and storage. For lignite-fired plants, these figures will be up to five percentage points lower depending on the moisture content of the coal, but that can be improved if developments in efficient coal-drying technology are successful, using either waste heat or low-grade steam.

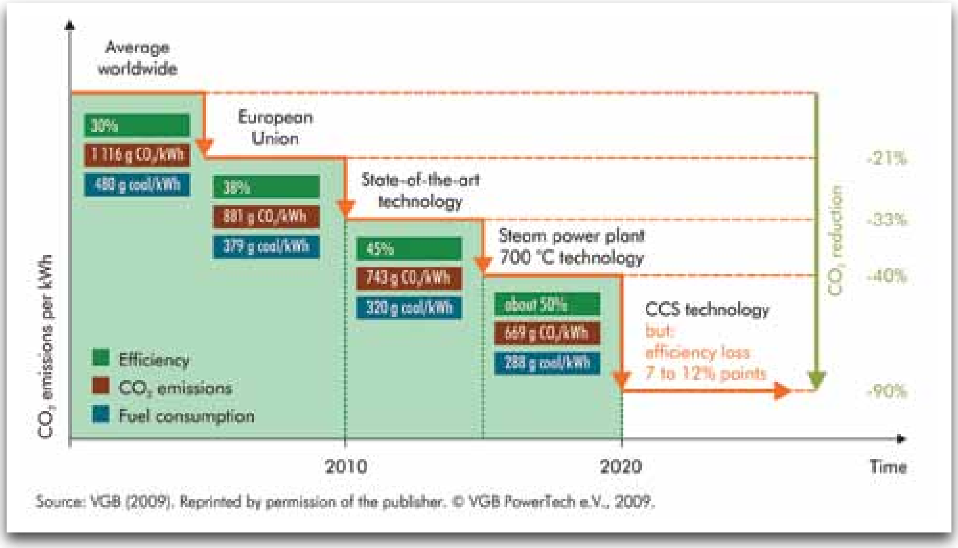

Figure 14 efficiency improvement potential at hard coal-fired power plants

CO_2 capture will impact significantly on the efficiency of both existing and future plants. At the current state of technology, units retrofitted with capture would suffer a decrease in efficiency of up to 12 percentage points, and consume perhaps 20% to 30% more fuel per unit of electricity supplied. While a concept of what constitutes "capture-ready" exists for new power plants, it may not be economic or technically viable to retrofit existing pulverised coal plants with CO_2 capture, especially at smaller units. Refurbishments will often be necessary to improve efficiency at existing plants before CO_2 capture retrofits can be contemplated. If 40% efficiency were to be considered the cut-off for CO_2 capture retrofit, around 10% of the world's current coal-fired capacity would be suitable for CCS. Even then, and assuming a route to storage, case-by- case analyses would be needed to assess whether existing control systems can be safely adapted and whether the large steam requirement of CO_2 capture equipment can be sensibly supplied from these existing plants.

Owing to the loss of efficiency, retrofitted units will deliver less power; additional new capacity would likely be needed to offset this loss. Based on new-build information, project proposals and forecasts it appears that while the majority of future plants will be either supercritical or ultra-supercritical, with efficiency above 40%, subcritical units will still have a significant market share. By 2030, up to half of the fleet might be considered suitable for CCS retrofit when necessary, while most of the remaining plants would require either upgrading to deliver high efficiencies or total replacement. Further work is needed to better define the future potential for CCS retrofit at coal-fired power plants.

CONCLUSIONS

Coal is the least costly and most accessible fuel for some of the most dynamic

developing economies. Its use at coal-fired power plants accounts for over 28% of global CO_2 emissions, a share that is rising. An absolute priority is to enhance plant efficiency, which can significantly reduce CO_2 emissions and the volume of coal consumed. Available technology can deliver fuel savings of 50%.

Worldwide coal-fired power plant efficiency averages around 33% (LHV, net output). Implementation of the suggested measures from IEA work carried out in support of the G8 Gleneagles Plan of Action could result in the replacement of some 300 GW and retrofit of some 200 GW of older coal-fired power plant capacity, while ensuring that all new plants are state-of-the-art. This could, if fully implemented, lead to a reduction of up to 1.7 Gt per annum of CO_2 emissions – which is roughly one-quarter of annual CO_2 emissions from coal-fired heat and power production – and a reduction in coal consumption of at least 0.5 Gt per annum.

To improve the operating efficiency of the global fleet of coal-fired power plants – and thereby significantly reduce CO_2 emissions – the IEA recommends that governments focus on the following policy approaches:

- New coal-fired power plants should be >40% efficient. Governments should look to replace by 2020 those coal-fired power plants built over 25 years ago and <300 MW. All other coal-fired power plants should be assessed for upgrading or replacement to achieve around 40% efficiency.
- International co-operation, training and financing mechanisms should be focussed on achieving the above best-practice efficiency objectives in the design, operation and maintenance of coal-fired power plants and electricity grids.
- The development and demonstration of those technologies that target higher efficiency at coal-fired power plants should be accelerated. For example, advanced materials, coal cleaning and drying, co-generation of heat and power, and more efficient CO_2 capture technologies all need to be deployed.

In addition to these efficiency improvements, the deployment of CO_2 Capture and Storage (CCS) technology is vital. The aim of reducing CO_2 emissions by 50% by 2050 implies that virtually all coal-fired power plants will need CCS by then (including some under construction now).

The Way Forward

Policy makers must reflect on what steps are now needed to improve the overall efficiency of power generation from coal. This report presents the tools for analysis and makes recommendations on how to use these tools to compare performance. This will allow poorly performing plants to be identified, wherever they are located. The costs and benefits of refurbishing, upgrading or replacing these plants can be estimated as the first stage in developing new policies that would encourage greater efficiency. The prize is large: some estimates suggest that 1.7 $GtCO_2$ could be saved annually. However, securing this reward would demand a major realignment of national energy and environmental policies, a realignment that may be less politically acceptable than allowing old, inefficient coal- fired power plants to continue running, in the hope that they will eventually fade away. Given that there appears to be no prospect of meeting global electricity demand without coal, governments must implement policies that respond more proactively to the growing use of coal, rather than wishing it away. Monitoring the efficiency of power plants and targeting those that perform poorly would be a step in that direction.

Earn CPD Credits

Nuclear Power

When the term Nuclear Power or Nuclear Energy gets used usually the first things that come to mind for most people are bombs, destruction, war, and deformed humans, which in fact are four things that occur the least in the nuclear power field.

BY I BJ BRYANT

Nuclear power is much more than just bombs and destruction; bombs barely even take up a percentage of the total amount of nuclear energy used in the world today. Most of the nuclear energy used today comes in the form of production of electricity.

Nuclear power plants are responsible for 16% of all of the worlds electricity production; which really may not sound like a lot, but when you think of the amount of electricity used in the world it really puts it into prospective how vital nuclear power is to us all.

The reason nuclear power has such a vital role in our society is largely due to the global warming trend, and the fact that nuclear power is much cleaner and more "environmentally friendly" than other forms of energy production. Nuclear power is not a very simple energy source to come by. It is produced through a very tedious and meticulous process that if controlled is very powerful and if uncontrolled is extremely dangerous, which is why it is a much regulated energy source, but without it where would we be?

THE PHYSICS OF A NUCLEAR REACTOR

Nuclear power does not just form off of some radioactively charged material like it is portrayed in some simple minded television shows. In fact it comes from a very tedious and meticulous process called nuclear fission.

Nuclear fission is a process by which a slow-moving neutron is absorbed by the nucleus of a uranium-235 atom, which in turn splits into fast-moving lighter elements (fission products) and free neutrons. This process creates massive amounts of energy in forms of gamma rays, and in the form of kinetic energy. Nuclear power plants perform this process within their nuclear reactors, where they can then use this kinetic energy to heat water that flows through the reactor into steam. At which point the steam will rise and spin a turbine that creates the electricity sent out to you and I.

DISADVANTAGES

Though this process seems pretty straight forward and hazard proof it is far from just that. The process of nuclear fission is one of the most dangerous processes known to man. There are so many things that can go wrong with this process that a few countries have refused to resort to it due to the horrible effects it has if something goes wrong. The most common thing that could go wrong in this process of creating nuclear power is the reactor over-heating.

This happens because the water coming into the reactor that turns to steam is also used as a coolant to keep the reactor from getting too hot and causing a melt-down. This could be caused by the outside temperature being too hot, which would not allow the coolant water to cool down enough causing a chain reaction in which a total nuclear melt-down occurs where it becomes too hot inside the reactor and the reactor splits and releases radiation into the air, along with a large explosion which shoots radioactive debris and ash into the air.

This such situation has only occurred once in the history of nuclear power production, and it will never be forgotten, the scars it left on the earth will be seen for many years to come.

The Chernobyl Nuclear Power Plant is located near the city of Pripyat in north central Ukraine. at the Chernobyl Nuclear Power Plant near Pripyat, Ukraine. On April 26, 1986 the situation described earlier was played out to a tee. The explosion shot radioactive fallout so far up that it was recorded to have landed in just about every Northern Hemisphere Continent. To this day radioactivity can still be traced in the area, so much so that the remains of the explosion have yet to even be cleaned up.

The Chernobyl disaster is thought of as being the worst nuclear power accident ever and rightfully so. The melt-down resulted in the evacuation of over 336,000 people, and resulted in 56 direct deaths, with 9,000 possible deaths within 20 years due to radiation exposure. The effects of this disaster were tremendous, but it also showed us how easily this stuff we were playing with could turn on us and cause a catastrophe. Which is also a cause for concern today in another sense.

Nuclear Power

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With all of the terrorist acts going on around the world today there is major concern in the way that a nuclear power plant is a very easy target that could and would cause much destruction should it be terrorized. There is really no defense against a terrorist attack on a nuclear power plant, and should there be one there is no way to stop the immense amounts of radiation from exploding into the air.

It would be absolutely catastrophic, anything and everything within a certain radius would be subject to overwhelming amounts of radiation exposure, and would most certainly die. So you can see why this is one of the main causes for concern with nuclear power plants today. Due to the very unstable nature of fission in general, let alone nuclear fission, these are the main set backs to the production of energy through nuclear power.

ADVANTAGES

However the question that needs to be asked is what is worth more, the minuet chance of a nuclear meltdown or a terrorist attack, or the massive amounts of energy produced at the minimal cost of nuclear power.

The reason why nuclear power is such a big rave is mostly due to the heightened costs of crude oil and other energy producing products. The initial cost of a nuclear plant is very high, but within the lifetime the costs saved by the use of nuclear power rather than say oil or coal will have paid itself off. Also, speaking of coal and oil, the amount of harmful emissions released into our atmosphere is very large compared to the amount released by a nuclear power plant.

In fact, this is one such thing nuclear power plants pride themselves on is the fact that they do not produce any environmentally hazardous emissions. This is a huge factor, especially today where the "Green House Effect" and "Global Warming" are two of the biggest topics in today's society. Everywhere you look there are people out there trying to think of new and improved ways to clean our earth, to save it from the harmful emissions we release into the air with our cars and our field sprays well here is definitely one.

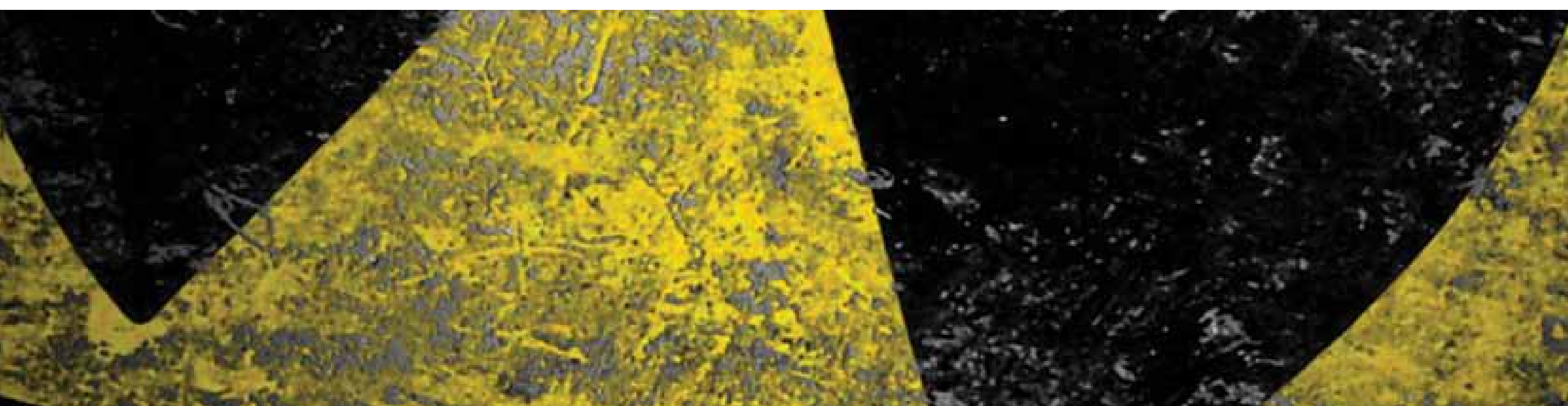
ALTERNATIVE USES

Nuclear power is not just a one sided source of energy. It does not solely produce electricity for our homes and offices. You can find nuclear power and energy just about everywhere you go now days. I say just about anywhere because just about anywhere you go has a smoke detector, and smoke detectors use an artificially produced radioisotope: americium-241. This radioisotope is extremely sensitive to changes in heat and allows the detector to sound the alarm if an intense amount of heat, such as a fire, were to come close to the detector. Another use of nuclear power that is not quite so common is in nuclear submarines. Nuclear submarines work pretty much like a small nuclear power plant. The same reaction takes place on a minor scale, and the energy produced powers the submarine. This was a major revolution in the technology of submarines, being able to stay submerged for days without surfacing, being able to conceal the position of the submarine. This became a very vital part of the most recent wars. Submarines are a very vital part to our national defense, and the nuclear energy that powers them makes it all the more efficient.

CONCLUSION

Today nuclear power effects, in one way or another, the majority of us 1. Through the process of nuclear fission we have electricity, smoke detectors, nuclear submarines, nuclear bombs, and much more. Plus with the production costs of nuclear energy being so much more reasonable it makes everything just that much easier for us all.

Certainly nuclear power is not something to just mess around with because it can and will turn on you in an instant, but with evolving technology and understanding we will someday be able to tame to great power of nuclear fission to the point where we may be able to use it in everyday life.



Earn CPD Credits

Load Shedding

For any electrical grid to remain stable the available generation capacity must match the load demand of the consumers, in simple terms 'supply must match demand'. At any one time the generation capacity of a system will generally be less than the installed capacity as certain plant will be out of service as a result of planned or forced outages. The difference between the national maximum demand and the available generating capacity is referred to as the 'Reserve Margin' and in an ideal world this should be around 15%.

If the system demand at any instant in time is greater than the available generation the system will become unstable and extensive and progressive blackouts may result. This would be catastrophic

CITY POWER JOHANNESBURG

This article will provide a brief history of City Power, the electricity utility which distributes power to consumers within the City of Johannesburg's licenced area of supply, and will describe the various options available to mitigate the impact of future load shedding should this be necessary to maintain the stability of the national grid.

BY | STUART WEBB | B.SC. (HONS) ELECTRICAL ENGINEERING

Load Shedding

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for the country and must be avoided even if drastic measures are necessary. If the demand cannot be quickly reduced to match generation large blocks of load must be intentionally disconnected.

In 2008 the national generation levels could not meet demand during peak periods due to unplanned unavailability of plant and the country experienced a series of forced outages which quickly became known as 'Load Shedding'. These forced outages resulted in extreme inconvenience to the public and adversely affected companies, businesses and the national economy. This was a new phenomenon for which the country was ill-prepared.

A BRIEF HISTORY OF CITY POWER

When the now defunct Metro Electricity, which was the City of Johannesburg's electricity service provider, was formed it amalgamated several former municipal electricity undertakings into one new utility. It brought together 5 essentially independent systems, namely

- Johannesburg
- Randburg
- Roodepoort
- Sandton
- Johannesburg South

There were also a few minor networks included such as Alexandra, Dainfern, Lenasia and Brink's Vlakfontein.

In 2001 Metro Electricity was rebranded as a new company and called City Power Johannesburg. More recently the Modderfontein and Midrand areas have been added to the supply area.

The technical designs of the former municipal areas are diverse in terms of plant and equipment, voltages and operating philosophies. These technical differences made interconnection of the various networks of little benefit and the systems are essentially operated independently.

City Power purchases the majority of its energy from the national generator, Eskom, for onward distribution to its customers. In addition a small amount of power is supplied from the independently owned and operated Kelvin Power station.

City Power's customer base is in excess of 360 000 and the maximum demand around 2 600 MW.

THE CHALLENGES

As alluded to above, City Power procures the vast majority of its power from Eskom and an alternative source of such magnitude is not available. Over the years countrywide load growth and development has resulted in Eskom's reserve margin falling below the internationally accepted level of around 15% due to various factors not always within its control.

In addition, Eskom's build program has experienced several delays and a significant reduction in grid capacity pressure is only expected to be realised in two to three years.

As a result the possibility of having to quickly reduce system demand during peak periods or following a major system event is ever present. Although a concerted effort has been made by all parties to inform the public of the precarious situation and the response from consumers has been positive the threat of load shedding still remains.

The impact of load shedding has a significant negative impact on the economy of region and, indeed, on the country as well as adversely affecting the lives of the citizens.

CURTAILMENT STAGES

In terms of NRS 048 – 9 various stages of load shedding are described.

- Stage 1 is defined as a 5% reduction in winter maximum demand
- Stage 2 is defined as a 10% reduction in winter maximum demand
- Stage 3 is defined as a 20% reduction in winter maximum demand

In City Power's case these stages would equate to around 130MW, 260MW and 520MW respectively.

The duration of load shedding can vary greatly from a few hours up to 8 hours or even longer in extreme cases.

OPPORTUNITIES

The City of Johannesburg and City Power have recognised the negative impact of load shedding on the economy and the citizens of the city. As a result the city has made a commitment to avoid a repeat of 2008.

Several mitigating opportunities to avoid emergency load reduction have been identified by City Power and have been or will be introduced. The various initiatives available will be described and discussed in the following sections.

KEY CUSTOMER DEMAND RESPONSE

City Power has a number of high consumption key customers whose annual usage exceeds 5 GWh. The activities of these companies differ widely but all have a potential ability to reduce or shift load

Ripple Control Coupling Cell

without necessarily halting or adversely affecting their production of operation. These companies are fully aware of the impact of complete load shedding on their businesses as a result of the prevailing conditions and are willing to assist City Power to mitigate this situation.

Presently City Power has identified around 112 key customers who have confirmed their willingness to voluntarily participate in a demand response scheme. The proposed, but as yet unconfirmed, repayment incentive rate is R1,11 per kWh and certain criteria will apply for the companies to participate.

It is estimated the potential load curtailment to be gained from this initiative will be around 80 MW.

GEYSER CONTROL

City Power has installed, over several years, an extensive network of geyser control infrastructure utilising ripple control technology. This form of demand side management is normally aimed at reducing the city's maximum demand during the morning and evening peak periods when energy purchase costs are at their highest. Geyser control can, in addition, be called upon to reduce demand when system capacity is tight or in an emergency situation.

The existing coverage is limited to around 60% of domestic premises although further expansions are planned. The present capacity of the ripple control system allows for an immediate reduction in demand of between 50 to 80 MW depending on the time of day and the season.

GAS TURBINES

City Power has three Gas Turbine installations situated around the JHB CBD. The capacity of these units is 40MW each or 120MW in total. The units had not been used for several years and had been mothballed. Following the 2008 load shedding experience two new refurbished engines were sourced and installed. The units were then operated but it was found the control circuits were unstable and

Cottesloe 40 MW Gas Turbine Installation

Load Shedding

continues from page 49

Kelvin 'B' Power Station

unsuitable for reliable operation. It is an option going forward to modernise the control systems allowing City Power to run these units to off-set demand curtailment requests at times of system constraints.

KELVIN POWER

City Power has a 20 year PPA (Power Purchase Agreement) with Kelvin Power which commenced in 2001. Kelvin has a reduced capacity availability of around 300MW following the recent decommissioning of the obsolete 'A' Station.

The unit price of Kelvin is higher than the Eskom Megaflex tariff and presently Eskom has contracted to purchase all output at the higher rate.

However, CP has an opportunity to utilise Kelvin's full available output as a contribution to its load shedding quota although this clearly has financial implications.

SOLAR GEYSERS

A roll-out of solar water geysers was initiated in late 2012 and the first phase involved the installation of some 60 000 units in various areas. It is the intention in the current financial year to continue with the installation of a further 10 000 units.

It is estimated these installations equate to an evening peak demand reduction of around 7MW and avoids a future potential load of 45MW from conventional electric geysers.

PHOTOVOLTAIC GENERATION

Presently City Power has received a significant number of applications to connect PV to its grid. Eskom funded projects amount to some 4MW alone with further privately sponsored projects in the pipeline. Fully regulated PV programs could yield tens of megawatts of power. Approval for grid connected PV and surplus power buy-back tariffs is awaited from NERSA.

In addition a number of larger companies have installed generation plant and they could also be contracted to operate their plant at times of system constraints.

The repayment rate and applicable conditions are presently being developed for submission to NERSA.

Typical Solar Geyser Installation

Typical Photovoltaic Installation

SMART METERING

A strategic decision to introduce smart metering has been taken by City Power. Both credit and prepaid options are available to customers. Generally consumers presently consuming < 1000kWh per month will be offered a prepaid meter.

In addition to automatic reading functionality the meters have a capability for communication and to switch domestic appliances such as geysers and pool pumps. It is the intention to fully utilise this functionality to control residential demand, where necessary.

RESIDENTIAL TIME OF USE (TOU) TARIFF

A residential TOU tariff is now available to City Power customers. The previously installed, older technology, meters were not capable of metering TOU consumption.

With the roll-out of smart meters the introduction of TOU tariffs is now supported. The intention is to incentivise residential customers, through tariff signals, to reduce consumption during peak periods.

It is also possible to control the actual consumption during periods of constraint by remotely setting a load limit which, if exceeded, would result in disconnection.

SUMMARY

Currently several options to mitigate the possibility of load shedding are available to City Power, albeit at significant cost. With the options available City Power can accommodate up to a Stage 2 request but any appeal beyond this cannot be complied with without the deliberately disconnection of customers.

City Power will continue expanding its geyser control systems to all areas – load can be quickly reduced and held off until constraints ease up. The roll-out of smart meters will proceed and the use of these meters to control network loading will also be implemented. New renewable and energy efficient technologies are being investigated such as photovoltaic (PV) power and energy efficient streetlighting - the City of Johannesburg, in conjunction with City Power, has initiated a project to generate electricity from the gas produced at two landfill sites.

The Demand Response initiative will be expanded.

It is confidently expected that these measures will significantly contribute to the national effort to reduce system demand and thereby minimise the need for the re-introduction of load shedding. wn

Domestic Smart Meter

RECRUITING?

TOP 5 USES OF POWERFUL TECH TOOLS

Today's recruiter has a range of powerful tools at his or her disposal to help make the recruitment process more efficient and cost-effective. From online jobs portals to social media, these tools make it easier to reach high-quality applicants, manage the flow of applications, and eventually complete the hiring process.

BY I KAREN EKRON I HEAD OF RECRUITMENT I SAGE VIP

However, recruiters should not treat applicants like online commodities or imagine they can automate their jobs end-to-end. Though it can help recruiters to gather CVs more efficiently and identify suitable candidates faster, technology is no replacement for the art of building relationships. Here are a few tips about how to get the most from today's tools and use them to make the recruiter's job easier.

MATCH THE TECHNOLOGY TO YOUR AUDIENCE

Recruiters love the ease of online recruitment tools - they're quick, easy, and often free. But as a recruiter, you must still apply your skill and understanding to the nuances of the job spec and specific client requirement.

All too often, recruiters use the wrong platform to attract potential talent for a particular position. Always ask where you are more likely to find the right talent. According to a survey by American company Jobvite, Ninety-four percent of recruiters are active on LinkedIn, whereas only 36% of job seekers are. Are you fishing where the fish are?

SOCIAL MEDIA CAN BE AN ASSET TO RECRUITERS

If you're considering calling someone in for an interview, it's a good idea see what sort of presence they have online. Of course, social media is not the only tool you should use to judge a candidate's suitability for your business, but it can add some colour to what you will learn about him or her from the CV and the interview. From their social media profiles, you may be able to get an idea of whether they'll be a good cultural fit with your business. And it could be interesting to see who follows them on Twitter or who their LinkedIn connections are.

Social media is also a good way to broaden your candidate database. If the position is attractive, your professional network can help you share it through Twitter, LinkedIn or Facebook, hopefully attracting some high-quality applicants. More and more people are looking for jobs using social media, but be sure you use the same channels as they do.

DON'T FILTER OUT GOOD CANDIDATES

When you go online and see hundreds of CVs in your email inbox or dozens of alerts on a career portal you subscribe to, it might be tempting to simply filter out those that don't meet your baseline criteria. For example, many portals and tools allow you to filter candidates by age, qualifications, and years of experience and so on.

Yet you should still assess every application to make sure that you aren't missing any gems in the rough. For example, someone who has less than your desired years of experience might have a great academic record and a solid degree. Or he or she might be missing an easily trainable technical skill, yet offer exceptional proficiency in another area of the job spec.

VIDEO IS NO SUBSTITUTE FOR FACE-TO-FACE CONTACT

Videoconference calls - using Skype, for example - are great for doing an exploratory discussion with a candidate who lives too far to travel for a first interview. But technical problems such as poor voice and video quality mean that doing an interview this way will always be a little unnatural for interviewer and candidate alike. Besides, a video interview is no substitute for meeting someone face-to-face and being in their physical presence. I'd recommend using video as a way to screen out unsuitable candidates, but a face-to-face meeting is still essential before you hire someone.

REMEMBER THAT RECRUITMENT IS AN ART NOT A SCIENCE

There are many objective data points that one should use in weighing up a potential candidate - skills, qualifications, psychometric tests, and so on. But softer points are also important - for example, whether a candidate has the right temperament for the role and how well he or she will fit in with the company culture.

This is proof that technology is unlikely to completely replace the skill required to recruit wisely. Persuading, negotiating, prepping, listening, understanding, and managing both the client and the candidate is a skillset no technology can offer.

Your experience and wisdom in assessing how well an individual will fit in and perform once he or she is given the job is how you perform magic for your business.

CONCLUSION

Technology is a powerful enabler of the recruitment process. Today's technology includes software that allows employers to manage their own recruitment process – filtering candidates, consolidating data and tracking placements. It can help you to free up time and be more productive - yet it cannot do your job for you and it probably never will be able to. wn

WATT? is a newly established forum related specifically to the industrial and commercial electrical sector.

Do you have any burning questions, topical issues or points of interest about the electrical industry, from the perspective of a contractor, supplier or professional service provider? Submit your comments, thoughts, ideas, suggestions or questions for the attention of our industry experts, and these will be addressed in a future issue of the magazine. This is your forum, and we would like to hear from you!

The rapid pace of technological change and product development is a global trend that affects entire economies. We may have access to more information than ever before, but is this information readily understandable? Does it give us insight into the fundamental issues? Is it precise and based on technical clarity?

WATT? is an opportunity for people on the ground to engage with each other and related professionals in an informative and friendly manner. This is a platform for you to discuss anything related to your particular sector, to highlight anything new, or to ask a specific question related to a technical topic or to engage in general industry issues. . Please note that we will not be considering anything related to the domestic sector, such as residential wiring.

We hope that this section of the magazine not only becomes a regular feature, but that it is widely read and distributed among your peers. Remember, it can only become a success with the full participation of our readers! Send your burning questions to minx@saiee.org.za - subject 'WATT?'.

We look forward to hearing from you.
- Ed

WATT?

EXPERT INDUSTRY ADVICE

QUESTION ONE

I have heard that high efficiency motors have a very high inrush current. Is this true, and if so what can be done about it?

ANSWER

To answer this question it is important to first understand the difference between locked rotor current (LRC), also known as start-up current, and sub-transient inrush current. The LRC is a constant value and its magnitude is determined by the design parameters of the motor, typically between 6 and 8 times the rated current. For example, when applying full voltage to the stator (DOL starting) the value of the LRC will be limited to the value stipulated on the given data sheet and will not exceed 20% of that value as per IEC 60034. Contrary to LRC, subtransient inrush current is a variable value and can be calculated mathematically by analysing the motor's voltage and flux immediately after energising it. The maximum flux amplitude reached on the first half cycle of the applied voltage is dependent on the phase of the voltage at the time it is applied. The maximum flux can be twice as high as the steady state flux, which results in a large increase in magnetising current.

Therefore the sub-transient current could peak at 3 times the LRC. This is true of all squirrel cage motors, regardless of efficiency class. As this lasts only for a few cycles (milliseconds), it is normally not detected by conventional meters. However, it could be detected by the instantaneous elements of protection devices (magnetics), which may result in nuisance trips during starting.

High efficiency electric motors generally have a lower X/R ratio than standard efficiency motors. Therefore the LRC is generally (not always) higher which, due to the phenomenon of all induction machines, could lead to higher sub-transient inrush currents. The percentage difference between standard efficiency and high efficiency motors is not constant but generally slight.

After many years supplying high efficiency motors to industry, the cases reported of nuisance tripping is so small that it is virtually unheard off. Although the inrush current is higher, it does not mean that it will affect all installations. In severe cases where the inrush current could cause concern, the issue is easily rectified by the correct selection and adjustment of protection devices used. The benefit of higher efficiency far outweighs the potential nuisance tripping that could occur due to incorrect selection and adjustment of protection devices or circuits.

QUESTION TWO

Can motors retain their efficiency after being rewound and what can I do to ensure this?

ANSWER

Yes, motor efficiency can be retained after being rewound. To answer this question it is important to firstly understand where motor losses come from and what could increase the losses. Motor losses comprise the following: Joule losses, iron losses, mechanical losses and additional or stray load losses.

Motor efficiency will only be reduced or affected negatively if any of the associated motor losses were increased. Motor losses are not just increased, however. They could be affected during a motor repair or a rewind, as per the following example:

The Joule losses (also known as I^2R losses) could be increased if the original winding specification was compromised, if different grades of copper or aluminium were used for the winding or when the quantity of copper was reduced by using a smaller diameter wire. Therefore if the resistivity or current flowing through the conductors was increased, then the losses will also be increased.

The iron losses are due to the magnetic field in the rotor and stator laminations and are dependent on the magnetic induction, frequency and the quality of the material used. If the laminations are being replaced, one should ensure that the composition and also the thickness of the steel were matched exactly to avoid additional losses. During the burn off process, one should take special care to follow the correct burn off procedure to ensure that the integrity of the steel laminations is not compromised.

The mechanical losses are due to the power requirement of the cooling fan coupled on the motor shaft and also due to bearing friction. These losses are directly affected by the motor speed. During repairs one should take special care to replace the fan or bearings with original equipment from the manufacturer to ensure that the losses are not affected. In addition, operating conditions such as ambient temperature, over greasing or misalignment also have an impact on mechanical losses.

Additional or stray load losses are caused by currents and magnetic flux resulting from high frequency components. Proprietary design techniques are used to reduce stray load losses. These developments are mostly unique to each manufacturer's manufacturing process.

Reputable rewinding facilities are able to guarantee original design performance by incorporating OEM material and processes in the repair. The only way to ensure this is to use repair facilities that are pre-approved and accredited by the original equipment manufacturer.

QUESTION THREE

When is it better to rather replace rather than repair an old motor?

ANSWER

It is important to realise that motors need maintenance and regular inspections. This hardly happens and is always questioned once the motor has failed. Once the motor has failed the next question is: "Should we repair or replace?"

So what's the right answer? It turns out that the decision to repair, rewind or replace a failed motor is not always so simple and straightforward as you may have heard.

Yes, a lot of times the repair cost is a lot less than that of a new motor, but the impact of the running cost sometimes outweighs the additional cost of replacing the motor.

It is a known fact that the motor consumes the energy equivalent of the capital outlay within weeks. The motor cost in relation to its running cost over the full lifespan is so small that it should make no sense to repair a motor in the first place. However, the decision to never repair a motor is not viable. This is when a replacement policy should be established with the following highlights.

- Does the motor suit the application and is it correctly sized?
- Is it a critical application where reliability plays a big role?
- Is it a catastrophic failure with huge mechanical damage? For example, a damaged stator core.
- Is there evidence of a prior repair and do you have records of the repair?
- Does the motor run for long periods during the year?
- What is the failed motor's efficiency rating? Now is a good time for a motor with increased efficiency.

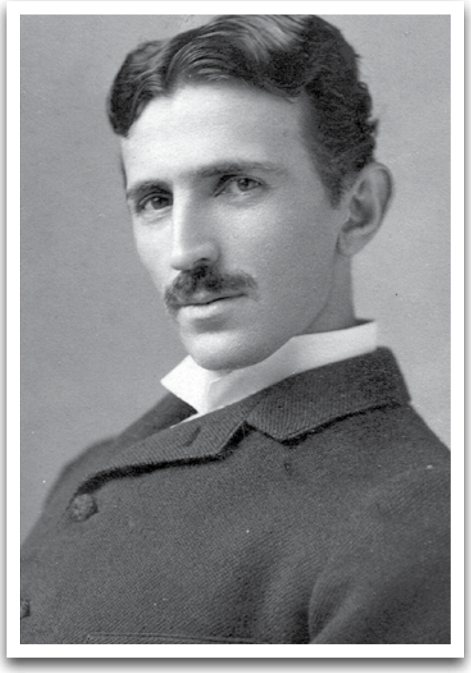
Upon failure, it is worthwhile to replace all older, lower efficiency motors with a high efficiency option as the energy savings alone justify this. The cut-off point for replacement rather than repair is a hugely debated topic, but the general consensus of large users of electric motors seems to be to replace any motor that fails < 45 kW or when the ratio between repair and replacement is higher than 60%. wn

Answers provided by Zest WEG Group

March

COMPILED BY | JANE BUISSON-STREET
FMSAIEE | PMIITPSA | FMIITSPA

March's birthstones are aquamarine and bloodstone. These stones symbolize courage. Its birth flower is the daffodil. The zodiac signs for the month of March are Pisces (until March 20) and Aries (March 21 onwards).



1 March

1893 Nikola Tesla, not Guglielmo Marconi, gave the first public demonstration of radio in his presentation, "On Light and Other High Frequency Phenomena."

2 March

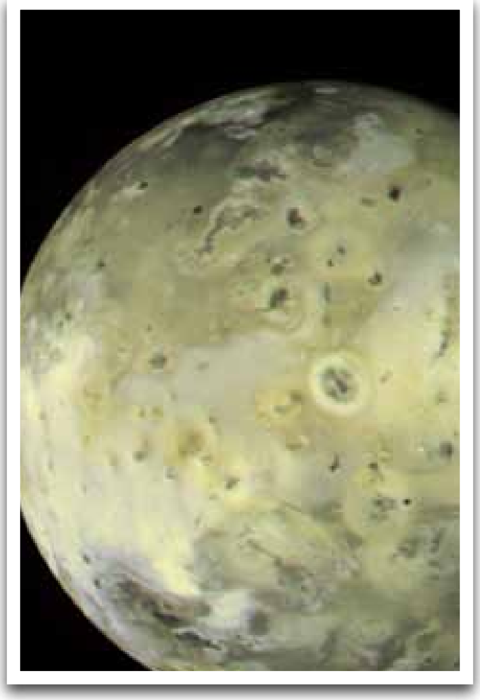
1925 South African Airways undertook its first flight between Cape Town and Durban.

3 March

1938 The longest cricket test match in history began between South Africa and England in Durban. Play went on until 14 March … nine days in total. England needed 41 runs to win at the close of the 9th day, but the match was drawn as the English players had to leave to catch their boat back to England. Due to the draw result, and the length of this match, it is often referred to as the "timeless" test, and the only one of its kind in history.

4 March

1793 The second inauguration of George Washington as the first President of the United States took place in the Senate Chamber of Congress Hall in Philadelphia, USA. He then gave the shortest inaugural address ever, 133 words.



5 March

1979 NASA's Voyager 1 made its closest approach to Jupiter, allowing for never before research and photos to be taken.

6 March

1869 Dmitri Mendeleev presented the first periodic table to the Russian Chemical Society, predicting that there would be more elements to come.

7 March

321 Roman Emperor Constantine I decreed that the Dies Solis Invicti (sun-day) would be the day of rest in the Empire.

8 March

1978 "Don't panic" but the first radio episode of The Hitchhiker's Guide to the Galaxy, by Douglas Adams, was transmitted on BBC Radio 4.

9 March

1562 Kissing in public was banned in Naples, Italy, and was punishable by death. Authorities were more concerned about public health than morality; a second plague was spreading through Europe like wildfire, and leaders were doing anything in their power to blunt the epidemic.

10 March

1535 After his ship drifted off course on a journey from Panama to Peru, Bishop Tomas de Berlanga of Panama discovered the "worthless" Galápagos Islands entirely by accident. Now a UNESCO World Heritage Site, the Galápagos Islands are considered a "living laboratory" of evolution.

11 March

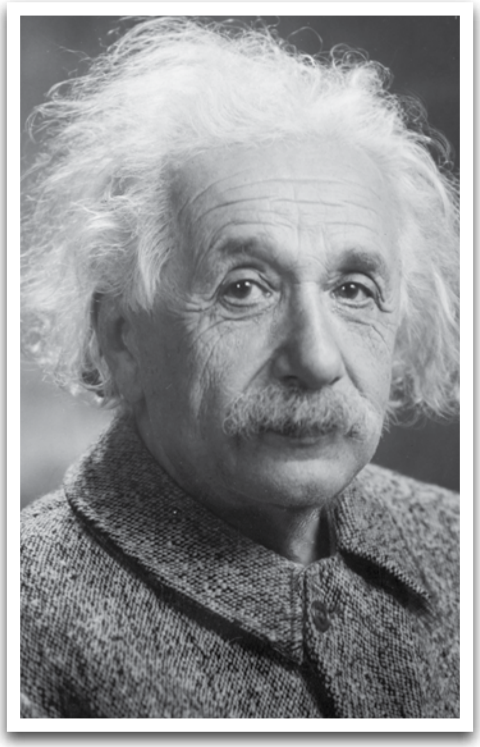
1890 Vannevar Bush, an American engineer, inventor, and science administrator, who was considered key to winning World War II and was, in effect, the first presidential science advisor, was born. As head of the U.S. Office of Scientific Research and Development (OSRD) during WW II, he coordinated almost all wartime military R&D including the initiation and early administration of the Manhattan Project .

12 March

2006 The Chicago Tribune claimed to have compiled a list of supposedly undercover CIA operatives, internal agency telephone numbers, and the locations of 24 secret CIA facilities by searching the Internet.

13 March

1930 After decades of speculation, "Planet X" was on its way to receiving the name "Pluto" once news of its formal discovery reached the Harvard College Observatory by telegraph.



14 March

1879 Albert Einstein came into the world, beginning a life that would become one of the most impactful in scientific history.

Some famed Einstein quotes:

- *"If we knew what it was we were doing, it would not be called research, would it?"*
- *"The only reason for time is so that everything doesn't happen at once."*
- *"Science is a wonderful thing if one does not have to earn one's living at it."*
- *"I am neither especially clever nor especially gifted. I am only very, very curious."*

15 March

1961 South Africa withdrew from British Commonwealth.

16 March

1872 The very first FA Cup final was won by the Wanderers FC, with a final score of 1-0 over the Royal Engineers AFC. The oldest football cup competition in the world was organised by the English FA (Football Association), which until then had only organised friendlies between clubs.

17 March

1901 Paintings by Dutch master Vincent Van Gogh were shown at the Bernheim-Jeune gallery in Paris, France. The 71 paintings, which captured their subjects in bold brushstrokes and expressive colours, caused a sensation across the art world. Eleven years earlier, Van Gogh had committed suicide having no idea that his work was destined to be so revered.

18 March

1965 Cosmonaut Alexey Leonov left his spacecraft for 12 minutes, making the first spacewalk in history. Due to problems with the spacesuit, Leonov almost could not re-enter the craft.

*** http://www.ThisDayinQuotes.com/*

March...

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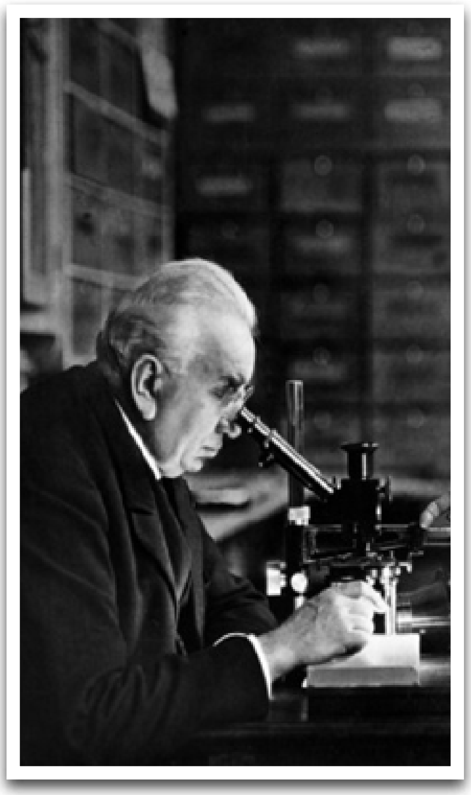


19 March

1895 Auguste and Louis Lumière record their first footage using their newly patented cinematograph, a competing device to Thomas Edison's kinetoscope. The film, La Sortie des usines Lumière à Lyon (Workers Leaving the Lumière Factory in Lyon), was a 46-second-long, black-and-white, silent documentary. It is a single scene in which workers leave the factory.

The cinematograph was a motion picture film camera, which also serves as a film projector and developer. Unlike Edison's kinetoscope, which had to be viewed by one person at a time through an eye-hole (peephole), the cinematograph could be projected onto a screen to be viewed by a large audience of people simultaneously.

20 March

1883 Shoe manufacturing was revolutionized by the lasting machine, which was patented by inventor Jan Earnst Matzeliger. Before the lasting machine, shoes were made mostly by hand. The machine could produce up to 700 pairs of shoes each day. Hand lasters produced only 50 pairs per day.

21 March

1965 NASA launched Ranger 9, the last in a series of unmanned lunar space probes, on March 21, 1965. The Ranger spacecraft were designed to take images of the lunar surface, transmitting those images to Earth until the spacecraft were destroyed upon impact. A series of mishaps, however, led to the failure of the first six flights. At one point, the program was called "shoot and hope". Fortunately the remaining Rangers were successful, culminating in Ranger 9's 5,800 images that provided strong confirmation of the crater-on-crater, gently rolling contours of the lunar surface.

22 March

1993 The first Intel Pentium was shipped, kicking off what would become a core line for the company and a well-regarded brand to the public. It was Intel's first superscalar x86 microarchitecture and, as a direct extension of the 80486 architecture, it included dual integer pipelines, a faster floating-point unit, wider data bus, separate code and data caches and features for further reduced address calculation latency.

23 March

1989 Two electrochemists announced that they had produced energy through a cold fusion reaction; opening the way for almost limitless production of cheap, clean energy. The claim was later found not to be replicable and cold fusion was given the cold shoulder.

24 March

1930 Planet Pluto was finally named.

25 March

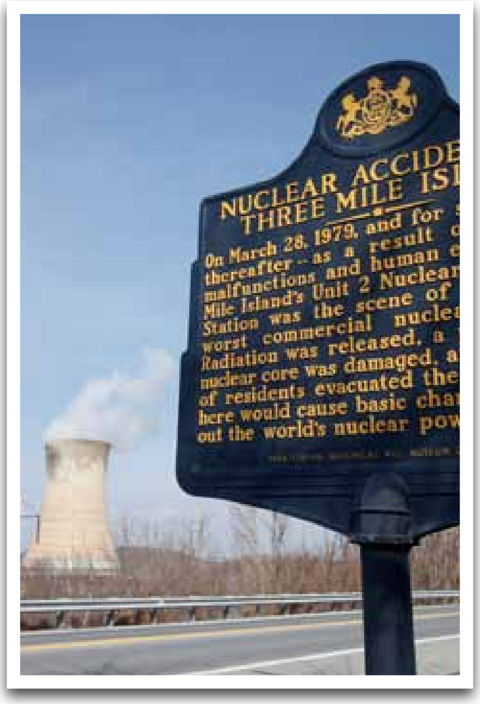
1979 NASA's first fully functional Space Shuttle, Columbia, was delivered to the John F Kennedy Space Centre to be prepared for its first launch. In total, Columbia flew 28 flights, spent 300.74 days in space, completed 4,808 orbits, and flew 201,497,772 km in total, including its final mission. Unfortunately Columbia was destroyed on February 1, 2003, upon atmospheric re-entry when a piece of foam insulation broke off and damaged the wing.

26 March

1958 The United States Army launched Explorer 3, its second successful satellite launch in the Explorer program.

27 March

1933 Polyethylene, the most common plastic, was discovered in 1898 and was rediscovered several times after that with chemists and researchers seeing little use for the white, waxy, substance. That was until 1933 when Imperial Chemical Industries' (ICI) (Northwich, England) chemists Eric Fawcett and Reginald Gibson rediscovered it by accident. One of its earliest uses was as insulation for UHF and SHF coaxial cables of radar sets during World War II.



28 March

1979 A coolant leak at the Three Mile Island's Unit 2 nuclear reactor outside Harrisburg, Pennsylvania, led to the worst accident in US commercial nuclear power plant history when the core overheated and a partial meltdown occurred – an occurrence that could have been avoided by better user interface systems.

29 March

1974 NASA's Mariner 10 became the first spaceprobe to fly by Mercury.

30 March

1975 Uruguayan master conductor Jose Serebrier accidentally stabbed himself in the hand with a baton mid-concert, and then continued his performance without missing a beat.

31 March

2003 New Mexico librarian Susanne Caro opened an 1888 book on Civil War medicine and discovered a startling memento: an envelope of century-old smallpox scabs. wn

IN MY OPINION : MIKE CARY

SONA 2015

The State of the Nation Address (SONA) is probably the most spoken about address in the history of the country. Because of the many distractions from forcible evictions to walk-outs, President Zuma's address included many items that have been lost in the wash. One of these is the promise that Government would make 23 billion Rand available to Eskom over the next 12 months.

BY I MIKE CARY I FSAIEE I PR ENG

The State of the Nation Address (SONA) is probably the most spoken about address in the history of the country. Because of the many distractions from forcible evictions to walk-outs, President Zuma's address included many items that have been lost in the wash. One of these is the promise that Government would make 23 billion Rand available to Eskom over the next 12 months.

Why is this money necessary, when the tariffs have increased by 2 figures each year for the past few years? To put this into perspective, we can look at the last available annual income statement at the end of March 2014. The income grew from R114,8bn in 2012, to R128,8bn in 2013, and to R139,5bn in 2014. In the same period primary energy costs grew from R46,3bn to R60,7bn to R69,8bn.

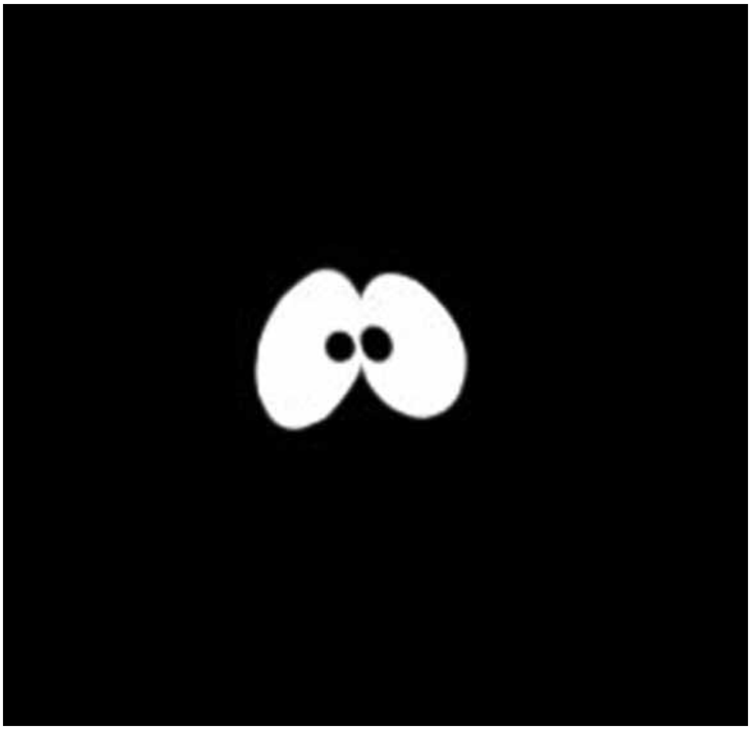
The cost of diesel for the Open Cycle Gas Turbines (OCGTs) contributed R1,5bn, R5,0bn, and R10,6bn to the primary energy costs respectively. This dramatic increase in the cost of diesel is the direct result of Eskom trying to keep the lights on by using the OCGTs which comprise about 5% of the installed capacity.

The total installed capacity of the Eskom generation fleet is 43 Gigawatt. Ideally, one should have at least 90% of this available, the balance being for planned maintenance and breakdowns. Currently, the Energy Availability Factor (EAF) is 70% to 75%, necessitating the use of the OCGTs, and the figure for the monthly cost of diesel is said to be R2bn. If this is required for 12 months, the cost will be R24bn – this could be part of the motivation for the R23bn from the Eskom shareholder – Government.

This situation can be improved if the EAF can be increased and the new machines at Medupi and Kusile come online. The cover story in the 25 January 2008 Financial Mail stated that Medupi would be completed by 2015, and the date for Kusile (then known as Bravo) was still to be advised (information sourced from Eskom). The quoted cost of these two projects was R84bn, and R88bn – about half of the current projections. The additional funding required for these projects has also put increased pressure on the Eskom finances.

The SAIEE is committed to assisting Eskom to improve its EAF – a short term solution to both Eskom and the Country's woes.

Some of the supply-side solutions are mentioned above. Another part of the solution lies in the demand-side and here all of us can assist by using electricity wisely and sparingly – it will also help your pocket!!



Everything's going Nuclear

Well - some wish it would, others vehemently hope it won't.

BY | ANGELA PRICE

Host a dinner party these days and there are a few things you can just about bet on:

- Table talk will eventually turn to the current SA power crisis;
- the 'Things in Zim started this way' discussion will inevitably commence;
- a tally will be given of friends/family who are leaving SA;
- and somewhere along the line things will go NUCLEAR (oh, and during the meal you will likely be load shed - as per the unscheduled schedule).

Yip, folks are pretty divided on the nuclear power generation issue.

If you were a fly on the wall at some of our family dinner parties you would likely hear my mother-in-law exclaiming about the dangers of nuclear, "My dear, I just read an article about babies being born near reactor sites, they have two heads - it's true!" *(My husband has a favorite saying, 'Too little information is just as dangerous as too much' - a point always well illustrated during our family discussions.)*

Her hysteria is usually calmly counter balanced by my husband quietly explaining the obvious benefits of nuclear power generation to those of us who have a more neutral, or (like me) completely clueless approach to this hot topic.

When I think of nuclear power generation, some of my first thoughts go to the Springfield Nuclear Power Plant.

For those of you not a child of the 80's, Springfield NPP is a fictional, boiling water nuclear plant which powers the whole of Springfield USA - home to The Simpsons (an American, adult, animated sitcom - watched by millions of kids in the 80's). The Springfield example painted a pretty strong anti-nuclear message.

To describe a just few of Springfield's operational examples/problems:

- Carelessness of the plant's employees (like Homer Simpson) often endangered the residents and the natural environment.
- The plant was notorious for being poorly maintained, largely due to the owner's miserliness and employee (Homer Simpson's) incompetence.
- A surprise inspection found 342 violations with an estimated $56 million required to bring the plant up to speed, money which management refused to spend.
- The core of the reactor was an outdated Fissionator 1952 Slow-Fission Reactor.
- The plant came close to a meltdown several times, and blew up at least once.
- Cooling towers cracked (fixed in one episode using a piece of chewing gum).
- The plant contents created a mutant subspecies of three-eyed fish.
- Oh, and the emergency exit signs at the plant were crudely painted on.

The irony is that whilst we laughed ourselves silly watching The Simpsons in the 80's, the Springfield example was almost a 'power prophecy' when looked at in comparison to our current Eskom scenario.

Fast forward to the SA present day:

- Carelessness of the Eskom employees recently tripped Koeberg's power, taking down one of their units (according to reports, 'the main reason for the failure of one of the two units at the Koeberg nuclear power station was due to the incorrect positioning of scaffolding in preparation for routine maintenance at the plant'.)
- Whilst they are not killing us, Eskom's woes are certainly killing the SA economy.
- The cost of fixing Eskom's problems runs into the billions - if only government had listened sooner and spent some money.
- At the core of Eskom's troubles are two power stations (Kusile and Medupi), both still inoperable.
- Whilst Eskom has not yet experienced an entire 'meltdown', they have had:
  - the boiler at unit three of Duvha power station explode;
  - a collapse of the central coal silo at Majuba;
  - an 'act of God' (lightning) triggering a chain of events which resulted in Lethabo power station literally drowning in ash.
- Eskom's infrastructure is outdated and years overdue for upgrades and proper maintenance. Eskom recently acknowledged that,"...almost all our power stations are experiencing all sorts of problems at this stage." Comforting to know.

And whilst I haven't seen any three-eyed fish recently; my mother-in law-knows about some two headed kids out there somewhere. wn

P.S. If the emergency exit signs (likely pointing to Oz) are going to be painted on, could someone kindly ask them to use glow-in-the-dark paint - thanks.

Calendar of events

If you want to see your function or event listed here, please send the details to Minx Avrabos at minx@saiee.org.za

MARCH 2015

11	Advanced Microsoft Excel For Engineers	Corporate Conference Centre, JHB	www.saiee.org.za
12	Power Transformer Operating Environment	Corporate Conference Centre, JHB	www.saiee.org.za
18	Understanding Transact, Db Optimisation & Database Design	SAIEE House, JHB	www.saiee.org.za
24	Revision Of Power System Fundamentals	Corporate Conference Centre, JHB	www.saiee.org.za
24	Power & Electricity World Africa	Sandton Convention Centre, JHB	www.terrapinn.com
26	SAIEE Annual General Meeting	Franklink Auditorium, Eskom Megawatt Park	www.saiee.org.za

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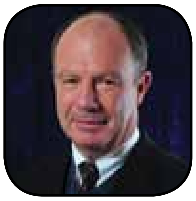

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