



POWER GENERATION IN A DEVELOPING ECONOMY
INTERNATIONAL EXPERIENCE FROM SOUTH AFRICA

Seminar 149 held on 14th May 2009
at the Institution of Civil Engineers, London

SUMMARY

KEY CONCLUSIONS

- Messages from those involved in government policies and advice recognise that past policies were wrong in both the scale and timing of impacts of energy demand. The economic model did not anticipate either the rate of growth in demand or the changing nature in patterns of use. To both curb demand in the short term and to raise capital to fund new investment, it was necessary to increase electricity prices by 27%, which was much less than needed.
- In South Africa the public sector investment, measured as capital investment of GDP, fell to 16%, leading to blackouts in the power economy. The Government has now begun a firm programme to lift this to 25%, which it believes is the minimum level to maintain a viable economy with rising demands within the global market place.
- Because there is no prospect of any new build programme for an entire country coming wholly from the private sector, and the lack of governmental budgetary mechanisms, a mixed economic model is needed for developing economies.
- Markets need a level playing field. For example independent power producers (IPPs) cannot compete on wholesale prices against vertically integrated power businesses. A strong regulatory body has to provide a long-term pricing regime and certainty.
- Multilateral and bilateral funding agencies such as the World Bank have to fund long-term operational costs as well as construction activity. This creates worldwide supplier development and participation models for lower prices in return for longer certainty and contracts.
- Having created the best possible economic background for new power generation, governments may still in some way have to provide 'sovereign' guarantees. Constructors can then bring global best practice by benchmarking and then resourcing alongside the world's best. However, because of the long lead times this still requires IPPs to have an appetite for risk and significant upfront investment. Sponsors, senior lenders, contractors and off-takers will then enter into meaningful contracts. There are global contractors and suppliers who are prepared to sign turnkey contracts.
- In parts of the world, markets have taken up to 30 years for full localisation of staff resources because of the scale and complexity of power generation programmes. These programmes are too large not to have government certainty and/or guarantees.
- Leadership skills are of most concern and are best addressed by global resourcing. One method to address the skills and knowledge gap is to set up a 'Silver Parliament' within organisations. These senior professionals then mentor and advise those in responsibility with less experience.

This international seminar was of particular interest to those engaged in power generation and distribution, as well as those with business interests in developing economies around the world.

Whilst South Africa is without doubt the land of opportunity, Chairman of the seminar, Sir Alan Cockshaw, noted that without power the economy will be greatly constrained and the job opportunities flowing from investments far more restricted.

The seminar looked at the opportunities and plans to develop, finance and construct new power stations to meet the rapid rise in demand for energy, and the issues which complicate this process. For instance, the wish to utilise the very latest technology for nuclear power stations raised questions about the application of first world technology to developing economies.

However, presentations were not just about the creation of power plants and their subsequent operation and maintenance, but about the development of the people who are involved in the programme. Such matters are fundamental to the future of South Africa and will make a significant difference to the quality of life of those who live there.

Speakers and contributors with extensive experience of power generation in other emerging economies brought their own lessons to add to the knowledge and debate.

REVITALISING SOUTH AFRICA'S ENERGY SYSTEM – THE CHALLENGES OF A MAJOR ENERGY BUILD

The first presentation, from a former minister in the South African Government, outlined the background to why the country was confronted with a serious electricity shortage in 2007–8, the steps that have been taken to change the situation, and why the evolution of a new strategy for infrastructure development in Africa is essential.

Plans for a major energy infrastructure build include a target of some 40,000 MW capacity over the next 20 years, of which 50% will be nuclear. These plans present significant challenges in terms of the capacity target, finance and choice of fuel source – it was noted that as the country comes under increasing pressure to commit to greater climate mitigation targets there must be diversification away from the use of coal as the primary energy source.

The plans also have implications for pricing and regulation, and raise issues for the development of energy infrastructure in the African continent as a whole, not just in South Africa.

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The build programme will involve a major partnership between the public and private sectors, as the option of either a fully funded state programme or a fully funded private one is not realistic at present. The role of Eskom was considered in some detail: established in 1923 as the Electricity Supply Commission by the Government of South Africa, it is the largest producer of electricity in Africa, and generates about 95% of the electricity used in South Africa. It was explained that how South Africa succeeds with its mixed model could provide important pointers to other African economies, and play a major role in providing solutions and building capacity in the continent.

The overall message was that the prospects for a sustained energy build are good in South Africa and that the effect on the economy during the current crisis is positive.

MAJOR PROJECT CONSTRUCTION CHALLENGES IN SOUTH AFRICA

The presentation from Murray & Roberts defined the challenge faced by the South African construction economy over the last few decades and how it has been impacted by trends in the global industry. The opportunities in the South African power programme and the public sector regulatory framework were outlined, and, using Murray & Roberts as proxy, the private sector response was considered.

The 'construction economy' is identified as a component of gross fixed capital formation (GFCF) within GDP. Ideally GFCF should constitute 20% to 30% of GDP, and the construction economy should be about a third of GFCF, i.e. about 7% to 9% of GDP. From 1946 through to the mid-1970s there was steady growth in infrastructure investment but by 1994–5 this had reached a low of 15%, with the construction element down to 2.5% of GDP, which effectively decimated the industry, including its skills base.

However, over the last 15 years since its transition to a full democracy, South Africa has been developing a policy framework around the ultimate objective of ensuring a better quality of life for its people. One of these policies is the [Accelerated and Shared Growth Initiative \(AsgiSA\)](#), the primary objective of which is to build the industrial capacity and deliver sustainable growth.

The plan by South African state-owned enterprises to invest in large-scale infrastructure programmes is expected to contribute to the targets, with the aim of reducing poverty and halving the unemployment rate by 2014.

Many initiatives have been implemented to prepare government, business and society for the road ahead. One example is the creation of the Construction Industry Development Board (CIDB) through which historically disadvantaged individuals, and small and medium enterprises can achieve priority targeted access to the mainstream economy. Today there are about 100,000 registered contractors in South Africa, and although many of them still at Tier 1 or Tier 2 there has been substantial progress in bringing new capacity through into the mainstream economy.

Another public sector led initiative, the [Competitive Supplier Development Programme \(CSDP\)](#) is designed to encourage the growth of a competitive indigenous supply chain, with commitment from the private sector and some level of sustainability underwritten by the public sector. Its objective is not just about investing in power stations: it is about creating a level of sustainable industrial capacity in South Africa that would build on its competitiveness during the programme, and become a force in the global marketplace. The presentation looked at its key features, how it will be implemented, and the potential commercial advantages of competitive local supply.

South Africa's planned power expansion presents South African private enterprise – and its construction, engineering and manufacturing industries in particular – with a developmental and sustainability challenge, and a key role for Murray & Roberts. Formed 107 years ago, Murray & Roberts has always seen itself as part of the national asset base of the country and has participated in many of the country's development projects. Examples of the company's investment in the national industrial base were outlined, one of the most important of which is the development and training of people within the country.

CHALLENGES AND SUCCESSES OF POWER GENERATION IN DEVELOPING COUNTRIES

As a global organisation whose activities encompass civil, transport and power engineering right across the value chain, and with over 90 years' experience in Africa, Parsons Brinckerhoff has a good insight into the technical and environmental challenges of energy generation across the continent.

This presentation looked at some of the challenges of power generation in Africa: technical and environmental, and the importance of achieving sustainability of capability within the indigenous population.

Africa contains practically every feasible fuel source for the generation of power, and is very rich in natural resources.

AFRICAN ENERGY RESOURCES – FUEL VARIETY



Hydroelectric Power Plant



Diesel Power Plant



Nuclear Power Plant



Wind Power Plant



Oil fired Power Plant



OC & CC Power Plant



Solar Power Plant



Geothermal Power Plant



Coal fired Power Plant

CC: Closed Cycle (gas fired)

OC: Open Cycle (gas fired)

Utilising these resources in a way that will power the continent's capabilities is fundamental to energy generation, and depends on various factors, including:

- Attracting investors and commercial banks
- Selecting realistic projects
- Decreasing project risk
- Strengthening the regional power pools

It was explained that such factors are likely to be interlinked: for instance the well-defined technical aspects of selecting any power generation project, such as fuel source and availability, location and capacity of the power plant, and the transmission system to evacuate the power, are all critically important in attracting finance.

Pooling power is a very useful mechanism by which power can be transmitted across countries and across borders to ensure sustainable supply. As far as strengthening the regional power pools is concerned, the facility is still in its infancy, but it was noted that the establishment and development of a transmission infrastructure that crosses country borders, with the support of power trading across those boundaries, is critical for economic growth in Africa.

The presentation also looked at some of the power generation successes from Parsons Brinckerhoff's portfolio of South African projects. One of these is the Medupi coal fired power station, which has come through all the challenges in terms of funding, environmental regulation and legislation and is going to add a tremendous power capability to southern Africa.

CIC Energy Corp. is developing the largest private sector power station project in Africa – the Mmamabula Energy Project (MEP) – at a capital cost of more than US\$3 billion. The power station will be located in Botswana, but the majority of the power will be sold to South Africa under a 30-year power purchase agreement. Botswana's Mmamabula coalfield (an extension of the Waterberg coalfield in South Africa) has extensive coal deposits, is in close proximity to the South African power grid and has easy access to Botswana's A1 highway, rail, power and water infrastructure.

Since the late 1980s investment in new generation capacity in South Africa has lagged, resulting in the capacity of the South African power system becoming constrained. Demand and supply imbalances have led to persistent load shedding, at a substantial cost to the South African economy. It was explained that the MEP is the only project that can meet the urgent demand for new baseload capacity in South Africa. With the financing process now well underway, the project is on track for the first power unit to be in commercial operation in 2013, followed by a second unit later in the same year.

The seminar heard about some of the challenges and successes relating to the engineering, construction, regulatory environment, stakeholders, risk mitigation and financial aspects of the MEP, which is the most advanced IPP project being developed in the region.

Part of the project development involves a long-term transmission solution which caters for significant future expansion. It has been created by CIC in partnership with Eskom and the Botswana Power Corporation, and involves a new high-voltage backbone connecting Medupi, Mmamabula and other new power plants that will be built to the west of Johannesburg. Capable of carrying 20,000 MW, it indicates how the infrastructure will be geared up to cater for new capacity in the region.

Some of the many advantages of the MEP were highlighted, for example the large volume of coal of proven quality, with detailed mine plans already developed and under CIC control; security of coal supply and a fixed-price lump sum turnkey engineering procurement construction contract for the power station.

The presentation concluded with key lessons learned:

- IPPs require host government support to establish a proper regulatory framework.
- Host country energy intensity is often too low to justify economies of scale, therefore large-scale IPPs need to be able to sell energy across borders.
- Negotiating power purchasing agreements with the domestic utility as the 'single buyer' is a problematic model with an inherent potential conflict of interest on the part of the utility.
- IPP tariffs need to be evaluated based on an independent and informed analysis.
- The distortion of utility pricing and utility accounting for incremental new-build costs results in difficult cost comparisons, though it is hoped that new rules by the National Energy Regulator of South Africa will address this.

This presentation from Westinghouse Electric Company looked at Westinghouse nuclear technology leadership, the company's global localisation experiences and successes in the global nuclear power market, and its approach to localisation in South Africa.

Westinghouse is the world's pioneering nuclear power company, and a leading supplier of nuclear plant products and technologies to utilities throughout the world. Westinghouse supplied the world's first commercial pressurised water reactor in the United States in 1957, and its technology is now the basis for approximately half of the world's operating nuclear plants.

Localisation is part of the company's fundamental set of values. It began in South Korea in the late 1970s, when Westinghouse successfully supported South Korea's goal to achieve self-reliance in designing, constructing and operating a fleet of nuclear power plants. Localisation programmes have since been initiated in many other countries, including China, where contracts are in place for delivery of four Westinghouse AP1000™ nuclear plants and the transfer of design and manufacturing technology to China. The objective is to achieve independent nuclear plant design by the end of the series of the first four plants, and for Chinese manufacturers to be able to produce AP1000 components and equipment.

It was explained that South Africa today is in a similar position to that of South Korea when the localisation drive began, with much the same spread of capability and businesses on the threshold of becoming nuclear industry suppliers as the Korean industry had some 20 years ago. New nuclear build presents opportunities in South Africa for both domestic constructions and the global Westinghouse supply chain, with immediate and long-term localisation opportunities.

Equipment localisation procurement programmes can help South African suppliers and manufacturers develop the capacity to compete for supplying future nuclear power projects globally, in addition to contributing to local project construction. Another feature of Westinghouse's role in South Africa is its commitment to supporting the AsgiSA programme. In conjunction with Murray & Roberts, the company is developing a skills programme for the industry that will best serve the country's needs.

Westinghouse anticipates localisation for first nuclear build in South Africa, building to near total localisation long term, based on the approach the South African Government decides upon. For instance, South African procurement is still at the stage where the Government is considering the best way forward. It was noted that regenerating the nuclear power industry in South Africa will require collaboration between the construction industry, the Government, and the various champions that are promoting the development

PBMR Ltd is a South African nuclear engineering company that has been developing a gas-cooled pebble bed modular reactor (PBMR) and pebble nuclear fuel since the mid-1990s. Based on a licensed design proven by the Germans over more than two decades, this is the first time that such complex technology has been developed in South Africa. PBMR Ltd stakeholders are the South African Government, the Industrial Development Corporation, Eskom and Westinghouse: it was noted that as the youngest nuclear company in the world, the support of companies like Westinghouse is important.

The company has developed the knowledge base, skills and capacity to absorb, understand, analyse and improve the original design and is now preparing to build a prototype of an envisaged fleet. With an outline of the background and the various stages involved in the pebble bed modular reactor programme, PBMR Ltd's presentation provided a sense of what it is like to develop 'first world' nuclear technology in a developing country, and looked at other opportunities for this type of reactor.

For instance, firstly the company had to gain an understanding of the high temperature gas reactor and pebble bed technology transferred from Germany. Design teams then had to be built up, suppliers found and a safety culture initiated. Initially South Africa did not have the regulatory environment in place to deal with the new plant and new build programme, and no system in place for the necessary Environmental Impact Assessment. The International Atomic Energy Agency (IAEA) was therefore invited to undertake a safety culture audit: well-defined structures and processes, and good internal and external communication are now a very important part of PBMR Ltd.

The next stages include building test facilities, a prototype, a fuel plant, the reactor itself and finally a fleet of power plants. In terms of staff, the company now has over 800 employees based near Pretoria, including engineers, scientists and others working on the fuel plant, and there is cooperation with various South African universities in furthering the company's research and development programme.

With the support of the South African Nuclear Energy Corporation (Necsa), PBMR Ltd have created the Nuclear Industry Association of South Africa, to provide coordination and focus, and to ensure that the industry can engage with the Government on issues of training, education, licensing, communication, media and localisation: in terms of localising the nuclear industry, the Government's Competitive Supplier Development Programme has played an important role.

The final presentation looked at the South African energy sector from the viewpoint of the South African National Treasury. The challenges faced over the last two decades were explored, particularly some of the issues around the financing of infrastructure.

By 2008, the country had all but run out of electricity: the reserve margin had been reduced to very low levels, while the low standard of power station maintenance and coal supply problems compounded the difficulties.

The problems in the electricity industry were mirrored in other areas of infrastructure such as road, rail and ports, airports and water treatment centres. Outdated, poor infrastructure became a binding constraint to faster economic growth and higher exports. In response, the public sector needed to raise its level of fixed capital investment, not only to reduce the constraint on economic growth but also to encourage more private sector investment: public investment alongside private investment is seen as critical.

In terms of the electricity supply, Eskom's plans for increasing capacity raised questions and debate about funding the investment needed – for instance, building one coal fired power station of 4,800 MW would require a trebling of revenue. Who would finance the investment: the fiscus, existing electricity users or future electricity users? Could private investors be brought into the energy market? The issues were complicated by the debate surrounding a fair price for electricity. Should the fiscus be used to control the price? Should users pay a realistic tariff? Would the regulator accept the principle that the user should pay?

In outline, the outcome was that the Government agreed that electricity prices would rise by between 100% and 120% in real terms over five years, Eskom would be granted a loan from the fiscus, and the rest of the money would be borrowed in the capital markets.

In summarising the main points, it was made clear that South Africa is committed to sustaining a large increase in infrastructure investment; from a macroeconomic point of view this is the most efficient way to raise the growth rate. The Government is working with all the major state-owned enterprises to ensure their infrastructure plans can be implemented, and that there is access to the necessary finance. The public infrastructure programme is not a three or five-year plan: there is a commitment to invest at the present rate over a period of 20–30 years, with the aim of achieving a gross fixed capital formation of up to 25% of GDP.

In his concluding remarks, the Chairman noted that the challenges faced by South Africa should not be underestimated, as the country's needs are enormous and urgent.

The importance of power generation to the future of the country was stressed throughout the day. South Africa is growing at a phenomenal rate, but continuing to grow depends on the sustainability of the investment. There was agreement from the speakers that the gross fixed capital investment must rise in a long-term, cohesive and holistic way. This was not only about creating power stations, but creating a mechanism without which South Africa's economy cannot go forward. In addition there must be commitment at all levels, and a government which understands what it means to deal with the industry in terms of safety culture, procedures, quality control and risk management within the regulatory environment.

One of the very strong themes that emerged was the social implications of the investment. Investment creates business opportunities and jobs, which are fundamental to the future of South Africa.

As a result of the seminar, the hope was that the network of people involved in helping South Africa achieve its objectives will widen and that more MPA members will become involved.



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