

Study shows power of energy outages on water sector

A newly-published study by the Water Research Commission (WRC) explores the effects of power outages on South Africa's water and wastewater services. Article by Petro Kotzé.

Without water, energy cannot be produced and without energy water cannot be transported or treated. Water and energy have a crucial dependence on each other and, if the one fails, the other is severely affected. In light of this interdependence between energy and water, and South Africa's electricity capacity shortfalls, the question begs to be asked: If the one does fail, what exactly will happen to the other?

This was answered during a recent study commissioned by the WRC on the impact that energy supply challenges are having on South Africa's water and wastewater services. Funded jointly by the WRC and the South African Local Government Association, the project aimed to provide stakeholders within the South African water and wastewater treatment sectors with an objective and logical evaluation of the current and expected impact and consequences of power outages on water and wastewater treatment services.

"We thought our findings may reveal that there is a national problem that needs to be addressed," says David Winter, Business Unit Leader from Frost & Sullivan, the international growth consultancy company tasked with executing the study. In order to address this research problem, the research team looked at, among others, the potential impact of power outages across the entire water supply chain and conducted a regional water demand impact analysis.

ENERGY USAGE IN SOUTH AFRICA'S WATER AND WASTEWATER SECTORS

Even though raw water resources in South Africa are of a high quality, especially in comparison to more developed nations, our challenges lie in water distribution. Gauteng's water supply, for example, is supplemented by a complex water transfer scheme from Lesotho. Still, South Africa has one of the most advanced water and wastewater sectors on the continent and according to the report, understanding our water supply chain is a critical component of analysing the impact of power outages in this sector.

There are numerous factors that

influence the amount of energy used in the water supply chain. The power outage impact assessment phase of this project firstly focused on analysing the potential impact of power outage events on each stage of the water supply chain, defined as water abstraction, water treatment, end-users, water and wastewater reticulation and water distribution and wastewater treatment:

- **Abstraction:** Energy usage within the abstraction phase of the water value chain is limited to pumping activities. Water abstraction schemes use gravity to move water, but when there are topographical limitations, high lift and booster pumps are used to lift water to a point where gravity can be used.
- **Water treatment:** The significant variation in the levels of water treatment between water boards and water service authorities directly influence the amount of energy consumed at each plant. For example, the country's largest supplier of potable water, Rand Water consumes approximately 662 kWh per Megalitre of water treated for its approximately 20 million water users. In comparison, Sedibeng Water (supplying the Free State and Northern Cape) uses approximately 1154 kWh per Megalitre of water treated. The latter's energy figures includes other operational costs, but the significantly

higher cost is because they do not use gravitational feeds.

- **Water end users:** Water is utilised in varying quantities by different end-users. By far the largest consumer, the bulk of irrigation water utilised is untreated and bypasses the traditional water supply chain (thus, largely left out of this study). On the other hand, limitations in water supply due to power outages could result in significant negative impacts on the mining and bulk industry, for power giant Eskom itself and for some urban commercial activities.
- **Water and wastewater reticulation:** Energy usage for the reticulation of water and wastewater is very similar to that of water distribution. Pumping is the largest energy consuming component, with telemetry control systems also requiring consistent power. The quantity of energy used is determined by the level of pumping required; in areas

where gravity is utilised significantly less energy is consumed.

- **Wastewater treatment:** In total, wastewater from the urban and commercial sectors, industry and mining equates to about 7 600 Mℓ of wastewater per day. In the entire water supply chain, wastewater treatment is by far the largest consumer of energy, but the amount of energy consumed differs significantly between different treatment plants. In general, the bulk of the energy consumed results from the aeration process. However, in the event of a power outage the treatment monitoring systems are also important to ensure that wastewater does not pollute the surrounding environment. The study found that both water and wastewater treatment processes utilise 'significant' amounts of energy.

In general, it was concluded that the water supply chain is impacted to varying degrees in the event of a power outage, depending on the characteristics of the plant and

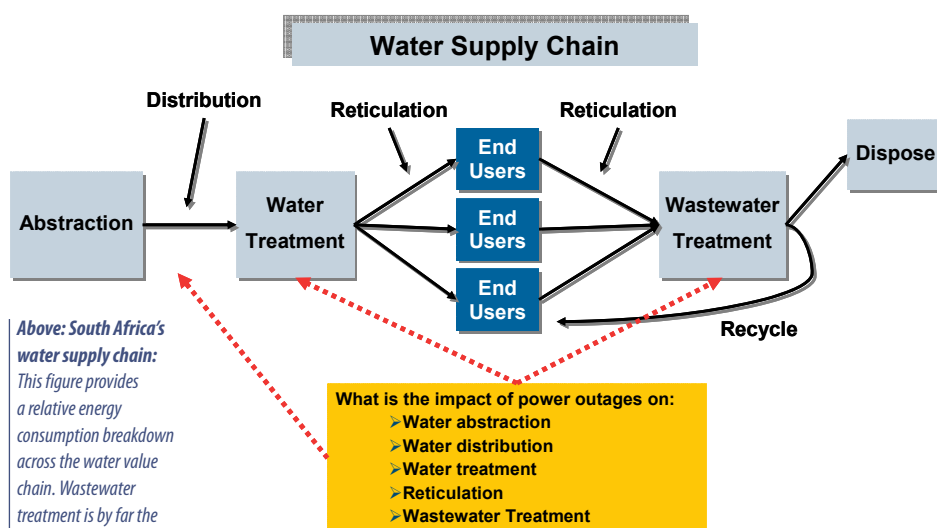
the availability of back-up power.

While pumping is the most vulnerable activity in the water supply chain, the use of gravity feeds can reduce the severity in many cases. While water security for end users is directly influenced by power outages on abstraction, distribution or water treatment points of the supply chain, water services authorities and water boards generally have sufficient back-up water supply to mitigate power outages.

Wastewater treatment is also very energy intensive, and hence vulnerable to power outage events. Again, plant characteristics dictate impact levels. Plants with back-up power supply and overflow dams are generally not impacted by power outages, but less prepared facilities can experience significant environmental, economic, health and social impacts. Overall, the amount of energy consumed in these treatment processes are influenced by a variety of factors, like the location of the treatment plant (and the resulting use of gravity or pumping feeds), the treatment technology used and the quality of water being treated.



In the entire water supply chain, wastewater treatment is by far the largest consumer of energy.



Above: South Africa's water supply chain:

This figure provides a relative energy consumption breakdown across the water value chain. Wastewater treatment is by far the largest consumer of energy with a range of 200 – 1800 kWh/M³ treated. Water treatment typically reflects lower energy consumption figures at 150 – 650 kWh/M³ treated. Abstraction, distribution and reticulation vary depending on whether gravitational feeds are utilised or not.

Right: Energy and water – the inextricable link:

Without water, Eskom would not be able to produce the country's power supply, necessary, among others, to provide water to users through the entire country. Eskom uses approximately 325 million cubic meters of water per annum to produce this energy, mostly by using coal to heat water, convert it into steam and release it to turn large turbines to create power. The majority of power stations were built in water catchment areas, but some need water to be transferred via pipelines, pumping systems and various other components between inter-basin transfers – all of which require energy to operate.

Source: American Water (2008)

Contributing factors that could aggravate load shedding include old and badly maintained water treatment plants (including the pipes used to distribute water to towns and cities), poor management and lack of skills among municipal staff, lack of funding and emergency preparedness, limited technical support and lack of monitoring equipment. Recent research by the Department of Water Affairs also revealed that the majority of wastewater treatment works do not operate within their

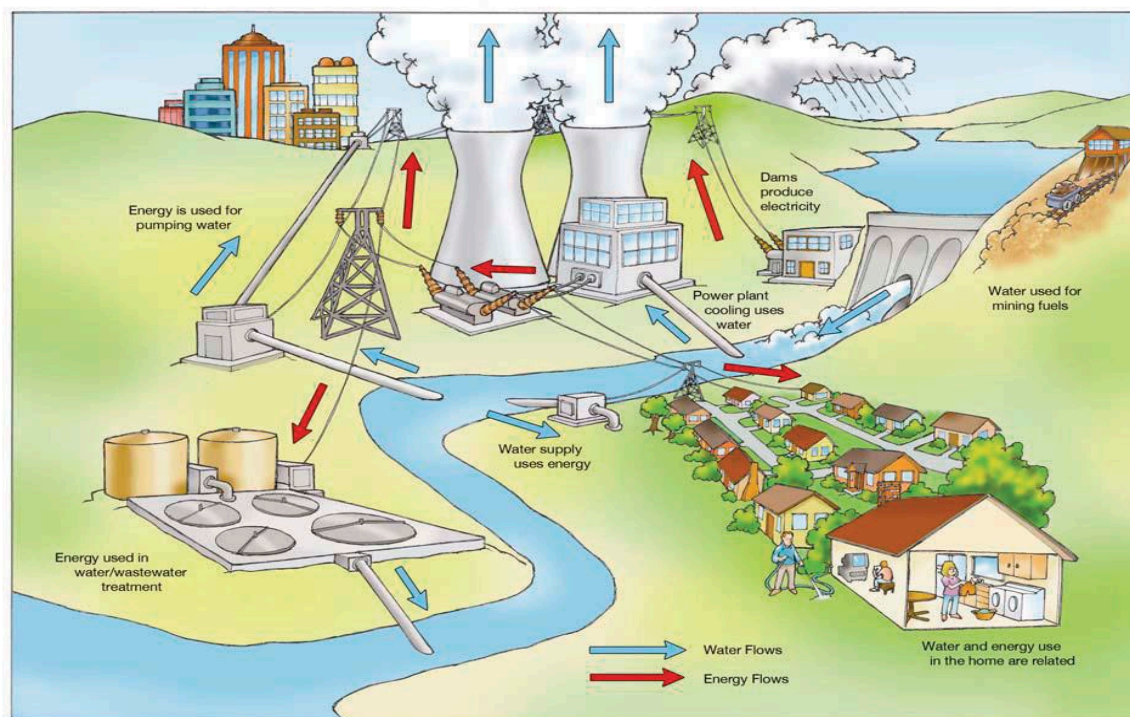
design capacity, which will impact heavily on the possible consequences of power outages. It is estimated that 40% of these do not monitor their volume of discharge and do not adhere to licence agreements, while the majority of plants are 30 to 50 years old and many are poorly managed.

A second tier of the analysis entailed a regional comparative impact analysis. This part of the study looked at water demand levels across the region, and focused

specifically on economic and social water requirements. Gauteng was identified as the highest risk area in terms of the potential impact of a lack of water services resulting from a power outage event. The high concentration of high water consumption economic activities and a large concentration of South Africa's population afforded it this status, while the Western Cape and KwaZulu-Natal were afforded medium level economic and social risks. More key areas that cannot afford energy and water shortages include manufacturing and mining industries.

The analysis found that power outages have, without any doubt, a direct impact on water and wastewater delivery in South Africa, across a range of economic, environmental, social and health areas and several examples of power outages event impacting the South African water supply chain were identified. The Cedarberg Municipality, for example, has been plagued with power outage events, which indirectly impact water and wastewater service delivery.

Besides the impact on the local community there is a real financial



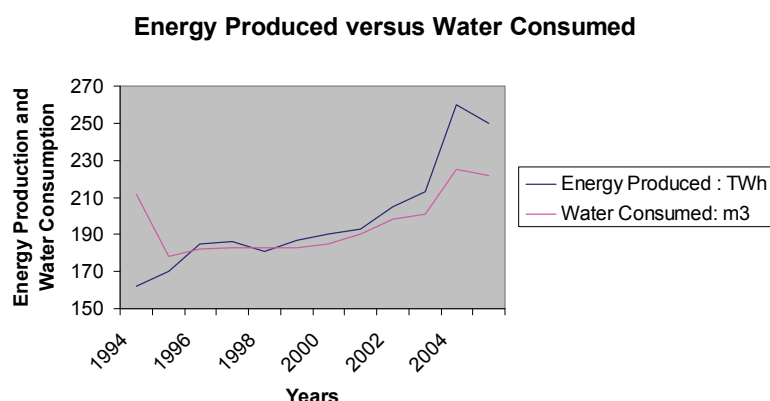
cost to provide back-up services. A case in the Ugu district revealed a direct impact on a commercial business, which resulted in a loss of revenue and salaries for casual labour. Other cases include health impacts in Howick, KwaZulu-Natal, environmental impacts at Zandvlei in the Western Cape and economic impacts for the City of Cape Town who has had to install back-up power supplies. All of these examples can be attributed to power outage events that have impacted the water supply chain.

In order to ensure that the impacts highlighted in the report are eliminated or at least reduced, the study results indicate that water decision makers and managers must take appropriate mitigatory steps or there will be costly consequences. "However," adds Winter, "an important finding was also that each location and treatment plant has unique characteristics that may or may not make it vulnerable to a power outage event." He adds that one cannot generalise about all treatment plants as many of them are unique and are in unique situations that may render them either vulnerable or not.

In general though, smaller providers who don't have back-up generators or sufficient plans to manage a power outage event, would be hardest hit by power outages, says Winter. For these service providers, challenges will arise when energy-intensive activities (like pumping or treatment) cannot function and either water cannot be delivered to end users or, there is a risk that wastewater will pass through a treatment plant without being treated and contaminate the receiving environment.

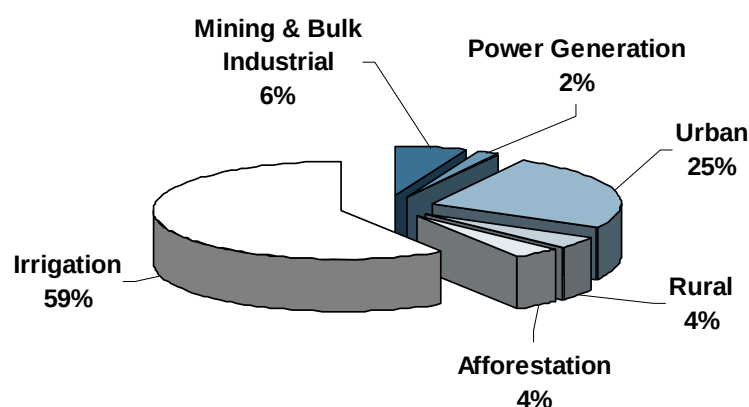
LOWERING THE IMPACT OF POWER OUTAGES

In conclusion, the analysis found that tackling power supply challenges in the water and wastewater sectors will require a multifaceted approach. No individual mitigatory



Top left: Energy produced vs. water consumed – The graph shows the relationship between the water consumed and the energy produced by Eskom from 1994 to 2005. Regardless of the various measures to conserve the use of water implemented, the graph clearly depicts the co-dependency that exists between water and electricity production.

Source: Eskom



Bottom left: South African end user water consumption breakdown – Water is used in varying quantities by different end-users. By far the largest consumer is agriculture, followed by urban areas, mining and bulk industrial, and then rural and afforestation.

measure will successfully account for every eventuality that may arise in terms of a power outage.

The key areas that should be addressed include improved communication between the water sector and the energy sector. If load shedding is required, critical processes along the water supply chain need to be prioritised. While large consumers of water like Eskom and Sasol work closely with water and energy service providers to secure levels of supply, this needs to be extended to smaller water services authorities.

A second key recommendation is on-site power generation capacity, seen as the best solution to ensure that critical processes continue to function in the event that power outages cannot be avoided. Additionally, it is imperative that personnel are adequately trained and know what mitigatory measures need to be implemented in the event of a power outage. Lastly, contingency plans need to be put in place so that water

managers and operational staff know what to do in the event of a power outage. This initiative should be managed and driven by the Department of Water Affairs and rolled out across all water services authorities.

According to Winter, "the value of the findings lies therein that we know that load-shedding will not cause a national-level crisis, impacting all treatment plants." Treatment plants and their vulnerability to power outages are location and plant specific. "In addition," he says, "most load shedding events are location specific and not typically at a national level, which further reduces the impact of a nation-wide risk."

- To order the report, *Power Outages and their Impact on South Africa's Water and Wastewater Sectors* (Report No: KV 267/11) contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; Email: orders@wrc.org.za or download an electronic copy at www.wrc.org.za 