



SA's POWER CRISIS...QUO VADIS...A PROPOSED *CARPE DIEM, CARPE ELECTRON* ("SEIZE THE DAY, SEIZE THE ELECTRON") EMERGENCY GAMEPLAN TO URGENTLY ACCELERATE THE ACCESS OF ELECTRONS AND STOP THE LOAD SHEDDING

by

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Disclaimer: The author wishes to state upfront that the views expressed in this article may not represent the views of all the members of the respective organisations he represents, given inter alia the diversity of the respective membership profile.

1. Introduction

Quo vadis is a Latin term which in very simple translation terms stands for ***"the journey...whereto from here"*** , hence the author thought it appropriate and apt to describe the current SA power crisis as such because it maybe the question that the majority of the approximately 60 million SA population are wanting answers and solutions to in the context of this national power crisis or emergency that all South Africans now find themselves in. Anecdotally they've had enough (hardships, inconveniences, etc due to the robust load shedding of recent) and are now wanting (demanding) for solutions from the relevant stakeholders especially Eskom. Given the journey that has led us to this crisis... can we turn the crisis around and get to a life of normalcy.

South Africa is currently experiencing a severe power crisis (not yet considered a national disaster) which is characterised and is exacerbated by inter alia significant robust or intense load shedding by Eskom, the main state power utility which supplies approximately 90% of South Africa's power capability. It is common knowledge based on available data that the load shedding is set to continue. Since last week, commencing 27 June 2022 Eskom has continually instituted stage 6 load shedding and the risk of escalating this to stage 8 has not been ruled out by Eskom.

According to Eskom load shedding is a planned and controlled process and the last resort measure of switching off parts of the electric network. If there is insufficient power station capacity due to sudden and unexpected trips, the electricity system can become unbalanced, which can cause blackouts and the collapse of South Africa's electric power system. If possible, Eskom will predict the risky periods and communicate via media, etc in advance a fixed period for scheduled load shedding.



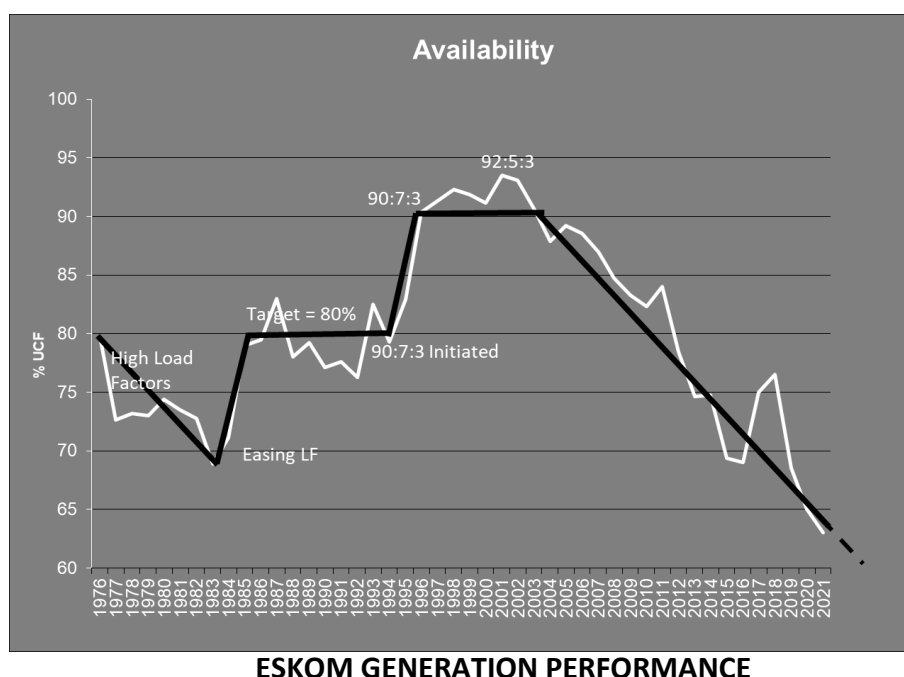
As South Africa's primary electricity supplier, Eskom can either increase supply or reduce demand to bring the system back into balance. But Eskom normally asks large customers to voluntarily reduce demand (load) (load curtailment) to keep the system stable and avoid load shedding.

There are eight schedules developed based on the level of risk. They were made in advance to describe a predetermined plan for switching off parts of the network in stages. There are 8 stages of load shedding which is managed and regulated by NERSA according to NRS 048 Part 9

2. THE BURNING PLATFORM, THE CASE FOR CHANGE

Giving context to SA's power crisis it's our understanding that the burning platform or the case for change is that the current performance of SA's power utilities (Eskom and municipal power utilities included) are seemingly and arguably fast accelerating downwards in a negative spiral and if NOT arrested and turned around as a matter of urgency the consequences for the end-use customer (let alone "SA Incorporated") is going to be diabolical because these power utilities may not successfully execute on their respective service delivery mandates.

Eskom's declining Energy Availability Factor (EAF) is also a serious cause for concern. The EAF is the percentage of maximum energy generation that the utility is capable of supplying to the electrical grid, restricted or constrained only by planned and unplanned outages.



ESKOM GENERATION PERFORMANCE

(Source: Nigel Volk, ex Eskom Gx Senior Manager, now Engineering Consultant)



3. THE PROBLEM STATEMENT

Our further understanding of the problem statement is how might these SA power utilities (Eskom and municipalities included) respond to their respective poor performances, current challenges, and emerging disruptors as a matter of urgency to enable them to meet their mandated levels of service delivery on a sustainable basis

The load shedding comes in the wake of other serious challenges that the country is currently facing, many of them underpinned by the current SA power crisis.

1. South Africa faces an unprecedented developmental crisis.
2. The pandemic has served as the final straw to plunge the country into its largest economic downturn in living history
3. Unemployment levels are at their highest on record,
4. Investment ratings have plummeted
5. Many in the emerging middle class have slid back into greater levels of poverty.
6. Meanwhile, the precarious state of state-owned entities – in particular Eskom power utility – remain a large burden on the increasingly constrained national fiscus.
7. An ailing coal- fleet and chronic power cuts continue to cripple economic growth prospects at a time that South Africa needs it most.
8. Rapidly increasing global concerns about climate change pose new threats to our economy, however, these also open up new opportunities

[Source: A 500-DAY GAME PLAN FOR SOUTH AFRICA'S ENERGY SECTOR, by Dr Grové Steyn, Celeste Renaud and Lonwabo Mgoduso; Meridian Economics; June 2021]

4. WHAT IS A CARPE DIEM, CARPE ELECTRON ("SEIZE THE DAY, SEIZE THE ELECTRON") EMERGENCY GAMEPLAN (at a high level)



Suggested rallying call.....during this power crisis (Source: VPA)



Let's start with defining and understanding the term ***"carpe diem"***.

Carpe diem, (Latin: "pluck the day" or "seize the day") phrase was used or coined by the Roman poet Horace is commonly translated as "seize the day" and was also made popular by Nike in their well-known "Just Do it" slogan.

It encourages people to focus on the present, appreciate the value of every moment in life, and avoid postponing things unnecessarily. To implement the concept of 'carpe diem' and successfully seize the day, one should focus on the present moment (the now) and take advantage of it as much as possible. Hence at its core, its essence carpe diem means do whatever is necessary, do whatever it takes to **"seize the day, pluck the day, seize the moment, seize the opportunity now**, not later to improve a situation and better a situation etc.

Hence ***carpe electron (seize the electron)*** as an adaptation and extension of the carpe diem principle or concept can also contextually be interpreted as a rallying call for/to action especially in terms of the current national crisis need for inter alia of all hands-on deck by all relevant stakeholders including business, community, citizens, government, organised labour to rally behind a common cause (rallying call) with minimal or no vested interests "clouding" the end result of in this case arresting Eskom's downward spiral performance and stopping the load shedding.

Given the urgent need for "tons of electrons" the author thought it prudent and appropriate that SA as a collective should embark and take on as a SA Incorporated at least for the next 2-3 years and "piggy backing" on the carpe diem "seize the day" principle or concept, the ***"carpe electron(seize-the-electron)"*** rallying call similar to the "90/7/3" rallying call that was successfully implemented in Eskom Generation during the late 1980's to the early 2000's that led to successful and sustainable achievement of 90% Availability , 7% PCLF and 3 % UCLF (aka 90/7/3 concept) in respect Eskom Generation's performance at the time

According to Lori Harris [*Forbes Article; "Maximizing Your Company's Rallying Call To Unify And Motivate", Lori Harris, 18 May 2020*] a rallying call is like the Mingun Bell in Burma or a lightning rod that strikes and lights an organic fire. When rung, or the impact of the strike informs, it kickstarts momentum, fuels inspiration and motivation and strengthens cohesiveness for vision, values and actions to thrive in people, teams and organizations.

Rallying calls make the best use of the organization's talent and stakeholders, its processes and systems.



It is important to understand that a rallying call is a theme and not a goal. In order for the energy to create momentum, a rallying call must have the full agreement and commitment of all team members.

To arrest the downward spiral in respect of Eskom Generation's performance what is urgently required now is "tons of electrons" onto the national power grid" ...approximately 5000 to 6000 MWs of electrons sourced from both synchronous /dispatchable power and inverter power sources.....mainly low carbon and renewables sources

Hence in the light of the above a **carpe electron "seize the electron" emergency gameplan** is a gameplan that inter alia includes the following principles;

- 1) This game plan assumes that the worst has happened i.e., in this case a complete "blackout, national grid collapse "has occurred. The process then in the development of this "carpe diem, carpe electron (seize the day, seize the electron)" emergency gameplan then entails working "backwards" and investigating/exploring options/scenarios/solutions that could have prevented e.g., a potential "national blackout" from occurring. In so doing then the following/below principles (especially the not so good/preferred ones are not ignored and/or given mediocre attention. In furtherance this approach is followed in the context that in a crisis and/emergency sometimes huge sacrifices may have to be taken or made in the national interest.
- 2) The declaration that this power crisis is a national emergency and for the establishment of a Power Crisis/Emergency Committee chaired by the President of the Republic of SA.
- 3) A rallying "all hands-on deck" call for action from all South Africans' to assist in the resolution of this crisis by coming to the party either empowered, incentivised, and not incentivised to providing the much-needed electrons onto the grid and for all the relevant stakeholders to commit to creating a conducive environment and landscape to enable the latter
- 4) All options/solutions – good and not so good are put on the table, discussed and considered.... Including best- and worst-case scenarios
- 5) All options/solutions – cost effective and not so cost effective, discussed and considered
- 6) All options/solutions – generally preferred and generally NOT preferred are put on the table, discussed, and considered
- 7) All enablers - – generally preferred and generally preferred are put on the table, discussed, and considered



- 8) The only requirement when considering this carpe electron “seize the electron” emergency gameplan is that all decisions taken for this emergency situation should not negatively impact, constrain any long-term strategic decisions that may affect this sector going forward. Any decisions that could have been taken in the long term but that could be fast tracked/brought forward and taken now is acceptable in the context of the “carpe diem, carpe electron (seize the day, seize the electron)” approach

5. SITUATION ANALYSIS

“The two primary reasons for load shedding are the unreliability and unpredictability of Eskom’s generation fleet ... and a lack of generation capacity in the country,” said Sikonathi Mantshantsha, Eskom’s national spokesperson recently to the **Daily Maverick newspaper**. Eskom had an energy shortfall of 4,000MW to 6,000MW of new generation to the national grid; an amount that would significantly reduce load shedding, Mantshantsha said. This does not tell the whole story, however.

“Kusile, three units are in commercial service ... and performing very poorly. So those units, even though it’s eight years later, are only producing at a quarter of what they should be,” he said.

However, the shortfalls of the plants and in capacity more generally are not the sole contributor to the energy crisis. Eskom’s Mantshantsha said “corruption has played a big role in the position in which Eskom finds itself today. Eskom has laid numerous criminal charges with the South African Police Service, disciplined and dismissed from its workforce employees found guilty of irregularities, and in some instances commenced legal proceedings to recover from third parties’ funds irregularly paid out.”

Presidential Climate Commission executive director Dr Crispian Olver also told the **Daily Maverick newspaper** recently that the major constraint to scaling up renewable capacity was that the grid was designed for coal energy and that the necessary reconfiguration for a renewables grid required “a major level of investment”.

COP26 saw South Africa benefit from a partnership that invested R8.5-billion into its just energy transition strategy. Olver said a large amount of the investment needed to go into upgrading the country’s grid.

“We need to put renewables on to the grid as fast as humanly possible. We estimate that we need about three to four gigawatts per annum for the next 30 years, which is equivalent to the entire REIPPP. There’s got to be a massive scaling up in terms of the



pace at which renewables are coming on to the grid ... we would be supportive of a mix of models, not just IPPs,” Olver added.

The ageing Eskom coal fired stations have also contributed a great deal to the current power crisis.

In this respect the author is also recognising that the ageing municipal infrastructure is also currently challenging and needs to be strengthened also as a priority to ensure that the national grid jointly owned in the main by Eskom and the municipalities as a collective is of reasonable strength and integrity to accommodate and access the “tons of electrons” that is urgently required on the grid.

The ANC’s statement on the outcomes of its most recent National Executive Committee meeting urged the government and Eskom to increase maintenance and improve the availability of existing supply; facilitate private investment in new-generation capacity; speed up the repurposing of power stations with alternative energy sources; accelerate the procurement of battery storage; empower municipalities to procure additional energy sources; and encourage businesses and households to invest in renewable energies.

The delay in ministerial guidelines on how municipalities can generate their own electricity was a barrier that needed to be reviewed, Nicole Loser, attorney and programme head of pollution and climate change at the Centre for Environmental Rights, told the ***Daily Maverick newspaper***. In 2020, Ramaphosa announced in his State of the Nation Address that municipalities in good standing would be able to generate energy independently, but the finer details on how this would be achieved have been sluggish at best.

The City of Cape Town has been spearheading municipal energy independence by shielding its residents from Stage 6 load shedding, keeping to Stage 4 with the Steenbras hydroelectric scheme.

The Association of the Municipal Electricity Utilities of Southern Africa (“AMEU”) fully supports the **National Planning Commission (“NPC”)** in respect of the following recommendations made recently by the NPC:

- a) To achieve the overall goal of 10 000 MW of new generation capacity and 5 000 MW of storage, it will be necessary to remove key obstacles. To this end, the NPC is of the view that:
 - I. the 100MW ceiling should be removed because Eskom’s grid code and grid connection authorization process is sufficient to regulate this growing market.



- II. any NERSA registration process that delays implementation of projects should be scrapped and replaced with an online registration procedure for database purposes only.
- III. environmental and water use approvals must be streamlined, to take advantage of the Renewable Energy Development Zone framework that allows for fast-tracking of approvals.
- IV. there must be a temporary exemption from local content requirements for construction and commissioning of new generation and storage capacity due to come online in the next 36 months. In parallel, key stakeholders should reach a formal agreement that strikes a balance between short-term importation of components with the need for phasing in upstream industrialization over the medium- to long-term.

The **AMEU** is also of the view that the aforementioned NPC recommendations will also contribute to some of the challenges facing the AMEU municipal membership to unlock or debottleneck some of their own challenges with respect to accessing the much needed electrons in an accelerated manner

Eskom's declining Energy Availability Factor (**EAF**) is also a serious cause for concern. The EAF This is the percentage of maximum energy generation that the utility can supply to the electrical grid, restricted or constrained only by planned and unplanned outages.

Furthermore, we are reminded of the following key strategic questions from a municipality perspective;

- a. is the current municipal service delivery model working? Is the current municipal service delivery model for providing basic services especially power/electricity related) contributing to increased standards of living, reduced household poverty and greater equality.
- b. There is a view that the current model of municipal services delivery is not going to deliver its developmental goals, noting also that such goals are the main reason for the existence of local municipalities especially in a post-apartheid democratic era post 1994.
- c. This is not just a service delivery or a local government problem: the failure of the municipal services delivery model is undermining all South Africa's other efforts to reduce poverty and inequality
- d. Within the constraints imposed by the current legislative and fiscal framework, the goal of genuinely affordable access to services cannot be achieved by most individual municipalities.



- e. Any sustainable solution must clearly prioritise universal access to quality and genuinely affordable basic services, over all other outcomes, and create an enabling regulatory and institutional environment to achieve that priority

[Source: Dr Tracy Ledger; Report; Public Affairs Research Institute, South Africa]

6. PROPOSED “CARPE DIEM, CARPE ELECTRON, (SEIZE THE DAY, SEIZE THE ELECTRON)” GRANDPLAN

6.1 SHORT TERM (0-2 YEARS)

- a) It's recommended that The President of the Republic of SA declares a power emergency which will inter alia seek to remove all “red tape’ and other pieces of applicable legislation, regulations, constraints, restrictions etc to enable especially Eskom and the municipalities to access all electrons onto the national grid on an urgent or fast track basis from various sources.
- b) It is also recommended that the State President establishes a Power Crisis/Emergency Committee and to be chaired by the State President himself and to meet weekly
- c) In the next 0-2 years NERSA should stop regulating in areas (excluding SHER related areas) where it is considered that in so doing by its processes it will delay the accelerated access of electrons onto the national grid. That said it is also recommended that NERSA given its particular mandate should leverage same to initiate actions, etc that will accelerate the uptake of electrons onto the grid.
- d) Municipalities must be fully empowered legislatively, regulatory, etc to be allowed to fully access all available electrons onto the national grid. The Electricity Regulation Act (“ERA”), s34 ministerial determination constraint should be removed. With this restriction removed municipalities can explore ways and means to make their power projects to access much needed electrons “bankable”, etc
- e) Though it was most welcome when it was introduced recently, Government must remove the 1-100MW licensing threshold. There should not be any upper limits
- f) Encourage and incentivise where possible and applicable viz through tax breaks, etc the uptake of low carbon/clean energy/renewable energy technologies from a variety of sources onto the national grid. In addition, the access of electrons from synchronous power/dispatchable power sources must **NOT** be ignored and must also be encouraged. Contrary to what is being punted, promoted, etc in certain quarters the power crisis and the load shedding cannot be averted by only accelerating the access of



renewable energy electrons onto the grid. Synchronous/dispatchable power through e.g., “small gas” (where and when available), hydro, affordable storage (mainly BESS) must also be considered in parallel bearing in mind that Eskom Gx is currently in the process of decommissioning 22000 MW of their aged coal fired power stations i.e. 9 of their 15 coal fired power stations in the next 10 to 13 years. Jan Oberholzer, Eskom’s chief operating officer, has said that the country needs to add 50,000MW of additional generation capacity to the grid over the next 13 years to cover the energy supply gap and replace retiring coal stations. Its our understanding that for every 2MWs renewable energy electrons brought onto the grid there should be an equivalent of 1 MW of synchronous/dispatchable power brought onto the grid to ensure a stable grid.

- g) Focus on IPPs to accelerate the access of electrons onto the grid
- h) Government must also consider giving priority attention to the restructuring of the Electricity Distribution Industry (“EDI”). Besides Eskom Gx currently “sitting on a ticking bomb” we could also be potentially sitting on a ticking bomb in the power distribution sector noting also that the “REDs” project was stopped in 2008. Restructuring only Eskom is a step in the right direction but it will not solve the power generation and power delivery crisis in the country.
- i) Municipalities must also focus on projects and initiatives that will contribute towards strengthening the grid infrastructure owned by them.
- j) The development of a national wheeling framework to facilitate the quick and easy access of electrons. Eskom and the municipalities can still have their own respective wheeling framework to suit their specific conditions but aligned to the national framework
- k) Eskom and assisted by the relevant state security agencies needs to as an urgency attend to the many known incidents of sabotage and corruption etc
- l) The shareholder compact between government and Eskom (as agreed) needs to be strictly adhered to by the respective parties. There is a perception that government gets into Eskom’s engine room more than it should thus not allowing the Eskom leadership the necessary flexibility, latitude to provide effective and efficient leadership and stewardship of the Eskom business.
- m) Bringing on board ex competent Eskom Gx personnel and their subsequent “deployment” in the field e.g., power stations to assist in the aforementioned remedial actions has to be very carefully thought out and planned to avoid “throwing the baby away with the bathwater”. Arguably many of the current power station personnel don’t know the calibre, level of competencies, etc. of the ex-Eskom Gx personnel and hence there maybe



“pushback” from the current power station personnel. It must be a two-way, competency building, information and learning sharing process.... sort of a mentor-mentee type relationship.

- n) Re-introduce the “old” **Eskom Sustainability Index** as a performance management tool for all senior management especially Eskom Gx leadership
- o) Eskom Gx should also give or pay significant attention and focus on the following **Generation Long Term Plant Indicators**:
 - I. **Overloading** (Accumulated hours at load greater than MCR) (Target, ideally zero)
 - II. **Turbo-Generator Vibration** (accumulated hours run with one or more vibrational indicators) (Target, ideally zero)
 - III. **Start-Ups** (Accumulated number of starts of a unit within the times of a shutdown or trip) (Target, varies depending on specific site conditions)
 - IV. **Electrical stress** (Accumulated hours operation with unit board voltages over or under specification by 5% or more) (Target, zero)
 - V. **Chemical Excursion Index** (A set of chemistry indices in which measurements taken on the plant of chemical conditions of steam, feedwater, etc, are normalised to a base of one (Target a result of 0,5 is excellent, a result of greater than 0,9 is not acceptable)
 - VI. **Thermal Excursion Index** (An index which approximates closely to the additional equivalent operating hours or extra life consumption experienced by boiler headers as a result of operation at metal temperatures in excess of design) (Target, ideally zero)
 - VII. **Trip Index** (Accumulated total automatic and manual trips of the unit on commercial load from loads in excess of the house (block) load, excluding the first trip during synchronising at house load (Target, ideally zero)
 - VIII. **Tube Metal Temperature Excursions** (The number of incidents of metal temperature excursions of whatever magnitude, experienced by the superheater or reheater tubes)(Target, ideally zero)
- p) Eskom Gx to focus on condition-based reliability maintenance, shorter General Overhauls (**“GO”**) with a view to increasing the level of Energy Availability Factor (**“EAF”**) from the current levels of <60% to levels of >70% to stop the load shedding. Beyond 2 years increasing the EAF to >80% will also enable SA returning to a life of normalcy from a power supply perspective. It is appreciated that these are not easy metrics to achieve but has to be strived for to achieve the desired outcomes as stated. It is also appreciated that Eskom Gx is constrained by not having “sufficient headroom” it is unable to effect proper maintenance. That said it needs to focus greater maintenance on its



better performing power stations and lesser on the badly performing much older power stations

- q) Commence on a selective basis the decommissioning of 9 of the “limping” 15 coal fired power stations with a view to inter alia maximising at all times the fleet EAF% and thermal efficiency % and most importantly maximising the amount of electrons that gets generated from these 9 “limping power stations”. The maximum focus should be on the six best coal fired power stations probably Medupi, Kusile, Matimba, Kendal, Majuba, Lethaba. Extracting whatever “synchronous/dispatchable” power electrons from these limping power stations is still very valuable especially in this 0-2 years critical period
- r) Commence reuse, repower, repurpose to access much needed electrons on an urgent basis. In this respect, Eskom as a priority should explore the implementation of a Eskom Generation “**REPOWERING**” project using various options e.g. “small” gas, hydro, storage (includes BESS) and other technologies (as applicable) to replace old or obsolete select coal fired power stations with a view to accelerating access to electricity urgently onto the grid.... “brownfields” versus “green fields” repowering projects will be quicker to access much needed electrons onto the grid. Going renewables only may not solve the urgent crisis. Maybe consider bringing in the private sector to assist in this repowering effort or initiative.

“Repowered projects often offer further cost-saving advantages, relative to new-build or greenfield developments, because they can use existing grid connections and transmission infrastructure. That includes replacing coal-fired boilers with gas-fired turbines. Hybrid power plants will also include energy storage systems like hydrogen, batteries, and thermal storage, and applications for supplying grid stability services. One main advantage of building a hybrid power plant on an existing infrastructure is that they offer significant cost savings and reduced lifecycle CO2 emissions, and they also enable synergies between new and existing assets”.

**[acknowledgement: “Power Mag”, 1 March 2022;
<https://www.powermag.com/repowering-provides-new-purpose-for-existing-plants/>]**

- s) Commission a study to make procurement quick and honest particularly for GOs.
- t) Outsource (where appropriate) key plant maintenance like pumps, mills, air heaters, precipitators, ash handling viz the Sulzer Pump contract was very successful in ratcheting up performance of Gx boiler feed water pumps.



- u) Power station units should be run according to current capacity capability – not just push to nameplate limit. Consider plant items out of service, coal quality, and known plant constraints. Pushing power station units accelerates degradation, increases future repair costs and time requirements.
- v) Focus efforts, budgets, and time on the low hanging fruit, prioritise those units that will be required to perform in the long run and return to OEM maintenance strategy, midlife refurbishments, acceptable coal quality etc. Try and get a reliable minimum installed base to meet system requirements i.e., includes probably 6 of “best” 15 coal fired power stations during the decommissioning period of 0 to 10-13 years
- w) Focus on the various Demand Response (“DR”) initiatives and especially accessing “Behind-the-Meter” (“BM”) electrons especially from the private sector, prosumers and prosumagers (prosumers with BESS)
- x) Ensure that the procurement process is functional again and the procurement function should fully service or support the business and its needs.
- y) Gx fleet thermal efficiency must be ratcheted up from its current performance to as close as to 32%.
- z) Simulators and their instructors must be brought back in place for operators and supervisors including apprentice training, professional registration, etc
- aa) The highly successful Eskom Gx “Project R” (also included the 90/7/3 journey) in principle should be implemented with associated procedures, accountabilities, and empowerment.
- bb) Explore or investigate (Eskom and municipalities included) the principle of a simplified grid access and reliability to minimize generation connection risk and complexity.

6.2 MEDIUM TERM (0-13 YEARS)

- a) Continue with projects, initiatives, etc that commenced during the aforesaid 0-2 years period
- b) Explore availability of affordable “big gas”, “big” storage (especially BESS) and nuclear (modular)..... both “brownfields” (repowering strategy) and “greenfield projects” noting that the country needs approximately 55000 MWs in the next 13 years while these “old” coal fired power stations are being commissioned. Hence the “lights will have to be kept” on during this critical transition period.
- c) Fully decommission in a prudent phased selective manner the 9 of the 15 Eskom Gx coal powered power stations

In closing the author is of the opinion based on his vast experience that although we are in crisis, emergency we can avert a disaster situation by just being prudent, fully committed and the leadership has to be decisive in taking the critically important decisions. Some initiatives,



projects, etc may in terms of this “carpe diem, carpe electron” emergency grand plan come at some cost and sacrifice but if the collective effort leads to a disaster being averted then such decisions must be given serious consideration.

[The author, Vally Padayachee has over 40 years’ “hands on” experience across all levels from operational, management, executive up to and including Board level in the power and energy sectors. His profile also includes having worked in such major blue chip companies as SAPREF Shell &BP Refineries, Mobil/Engen Refinery, Eskom Gx, City Power JHB and Altron Power (Powertech)]

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