National Blackout Planning

Stakeholder, National Sector & Provincial Engagement

Rev 7.3

Presentation: SAPIA (Security)

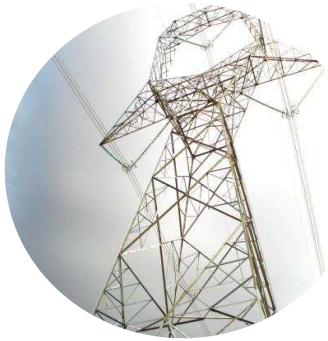
Date: 10 July 2015

- Initial engagement session
- Template discussion
- High-level sector response strategy
- Sector response plan
- Integrated country plan

Contents

Background

Electricity plays an essential role in the South African economy and in society in general. A major electricity-related incident can therefore have a significant impact on the country or a specific region. The prevention of such incidents, as well as the ability to effectively respond to and recover from such incidents is an essential requirement of effective disaster management.



In terms of the Disaster Management Act (No. 57 of 2002), coordinated sector planning is required in order to manage electricity-related disaster threats or incidents. Sector engagements are currently underway to assess the plans in place and to enhance coordinated planning.

Eskom's priority disaster scenarios

Priority	National Disaster Risk	Provincial Disaster Risks
1	Nuclear incident National industrial action (Eskom/SA) National blackout Severe supply/demand constraint	Major system constraint Snow/ice storms Floods Regional blackout Social unrest
2	Severe drought Solar/geomagnetic storm Terrorism Political instability Pandemic/disease (Ebola)	Tropical cyclone/Anticyclone Air/water pollution/contamination Veld/forest fires Water control structure/dam/levee failure
3	Economic/financial collapse Extreme temperatures National liquid fuel crisis	Earthquake Tsunami/storm surge

A national blackout is not considered an imminent event; it is one of the electricity disaster scenarios for which Eskom plans

Purpose

The purpose of this presentation is to:

- Provide an overview of **Eskom's planning to prevent, respond to, and recover** from a national blackout.
- Support coordinated planning with **national sectors and provinces** in support of current initiatives to enhance national preparedness for a national blackout.

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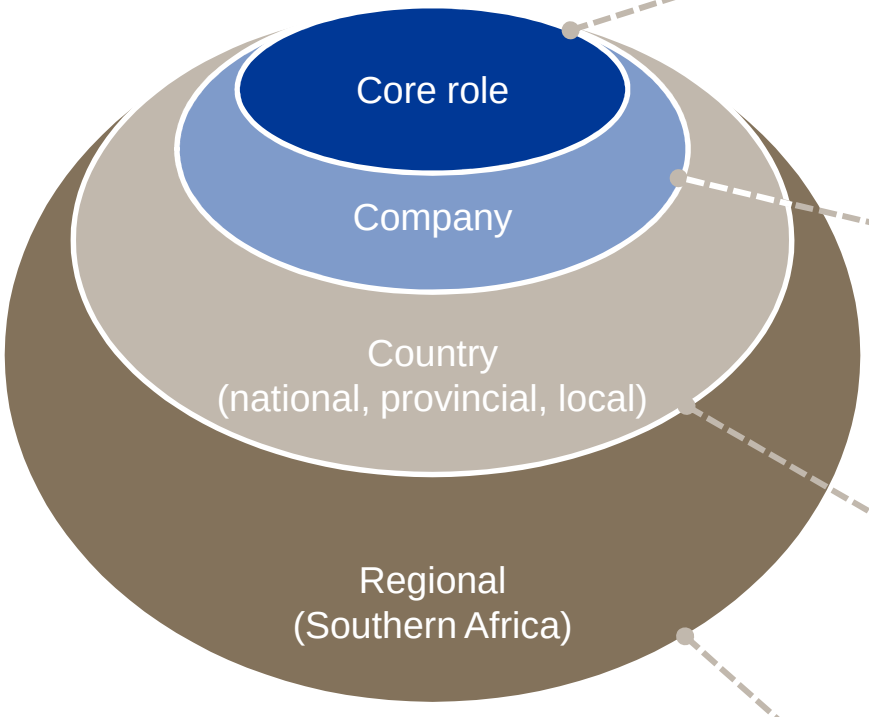
Coordinated sector planning (Eskom core role)

Sector Disaster Management Roles



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Blackout prevention, response and recovery

- Power system operations & protection systems
- Black start facilities & islanding
- Execution of black start system restoration plan

(System Operator, Generation, Wires Business)

2

Organisational response & business continuity

- Integrated emergency response & comm's
- Continuity of critical business operations
- Safety of staff & the environment

(Divisions, Provinces)

3

Collaborative planning and response:

- National, provincial, municipal disaster structures
- National sector departments and organs of state
- National/provincial crisis communications
- Stakeholders

(NDMC, PDMC's)

4

Collaborative planning and response:

- South African Power Pool joint planning
- Support to the NDMC in engaging SADC countries

(South African Power Pool, NDMC)

Terminology - general

Interruption of supply	Separation of a customer or group of customers from the Interconnected Power System (“grid”). Usually localised.
Load shedding	Controlled rotational interruption of supply in order to prevent a complete blackout of the power system
Regional / area blackout	Separation and de-energisation of a significant portion of the transmission system. e.g. Western Cape blackout. All customers connected to that portion of the network lose supply.
Network island / separation	Portion of the grid separates from the main grid but remains energised and stable with generators in the island supplying customers in the island.
National blackout	The complete de-energisation of the South African power system. Generators may “island to house load”. All customers lose supply.

Terminology – system restoration

Black start	The systematic re-energisation of the power system by connecting generators to customers via the transmission system. "*Re-booting the power system*". Power stations are started sequentially.
Self start	The ability of a generator to start generating without the assistance of an external supply.
Black start facility / generator	Ability of a generator / power station to start generating without the assistance of an external supply and start a base load power station.
Restoration	The process of restoring supply to customers and normalising the power system.

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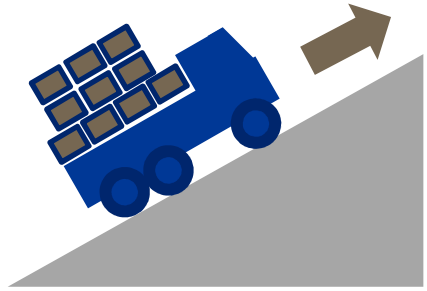
Why load shedding ?

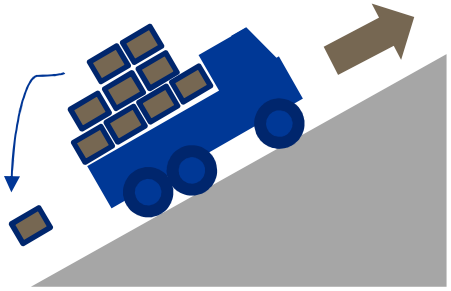
To provide assurance that national power system security is being managed, load shedding needs to be implemented prudently.

1. If the engine capacity is too small for the truck's load, the engine slows



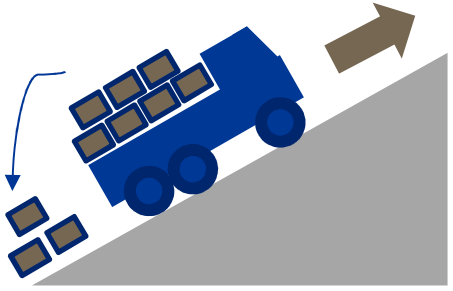
If available generation can't meet system demand, system frequency drops < 50Hz

2. To prevent the engine from stalling, load is shed in a planned manner



Eskom proactively implements *controlled manual load shedding*, 4 scheduled stages (1000-4000MW)

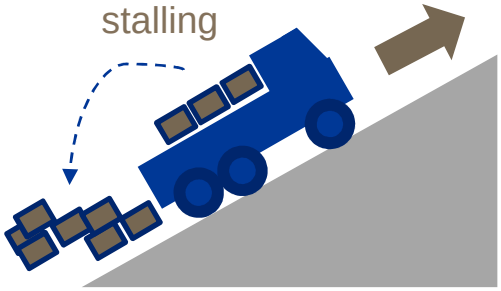
3. Business suffers, but the truck moves and the engine is no closer to stalling.



The system is no closer to a national blackout, even if we need further *unscheduled shedding*

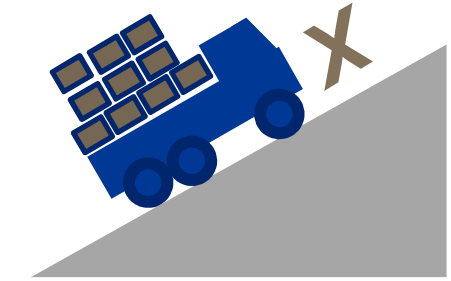
What if we don't get controlled load shedding right, or things happen too quickly?

1. Automatic mechanisms can shed up to 50% of the load, this prevents stalling



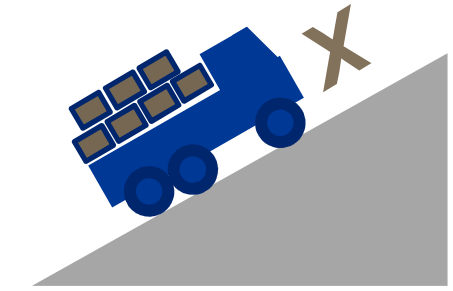
A blackout is averted by the automatic protection scheme, multiple automatic layers.

2. If this all fails, the clutch automatically disengages, the engine runs, the truck stops



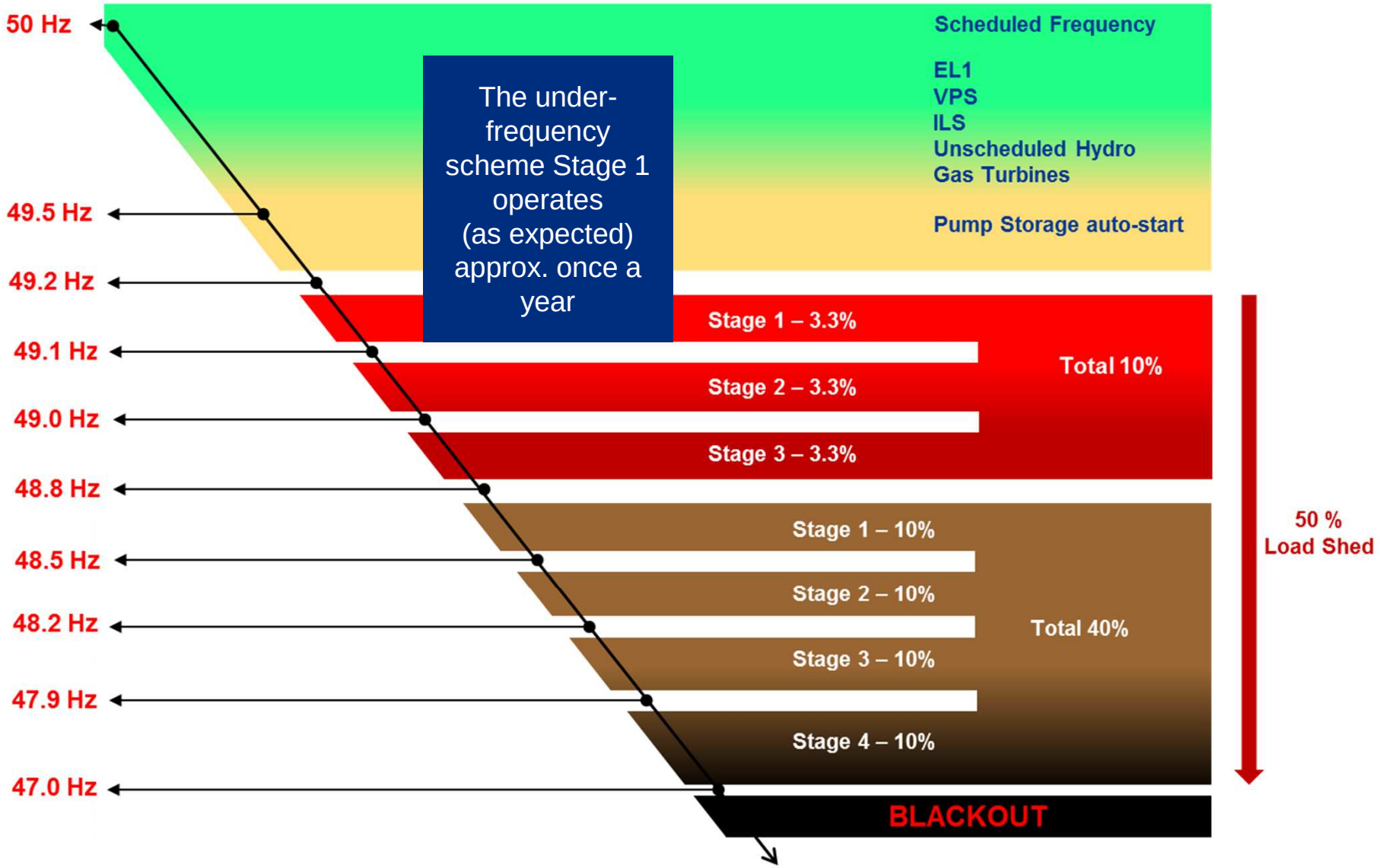
A blackout occurs, some generators *island*, it takes days to restore most electricity supplies

3. If the engine stalls, we need to use the starter motor – for this the battery must be good.



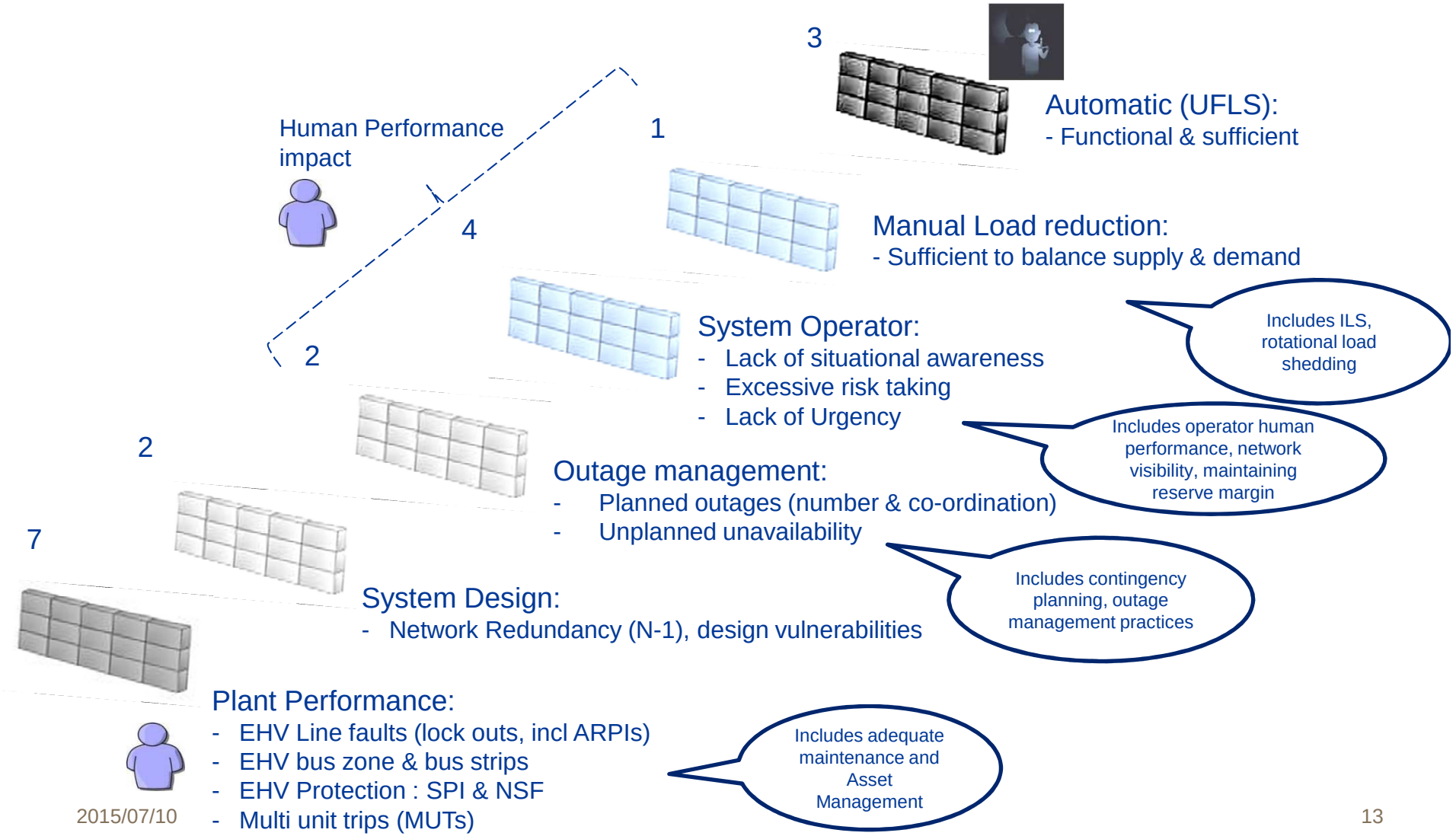
A *full black start* is required, it takes 8hrs to start, 2 weeks to restore most electricity supplies

Under-frequency protection system

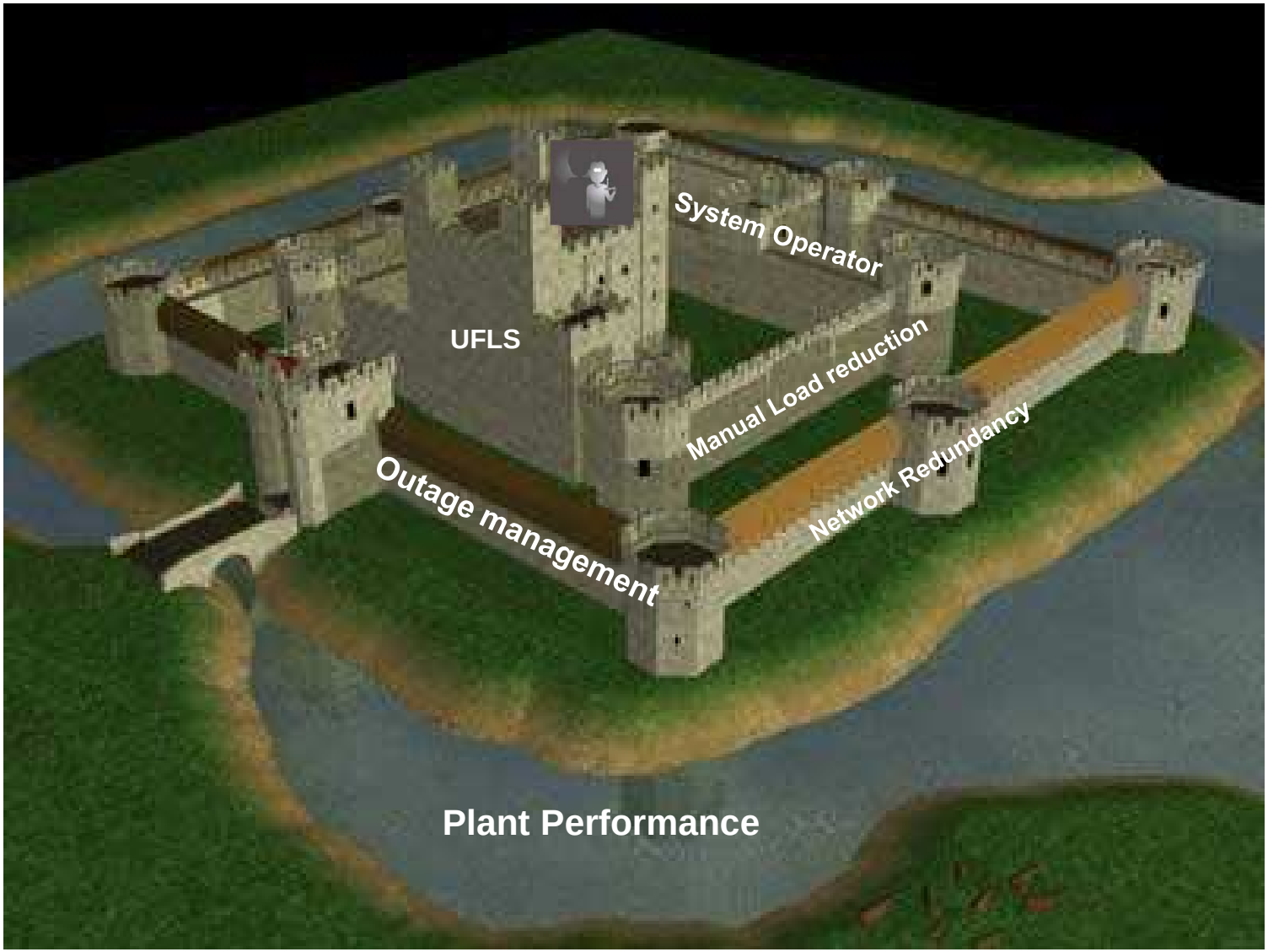


Barrier Discussion & Definition

Top 10 International Blackout incidents: contributory causes breakdown

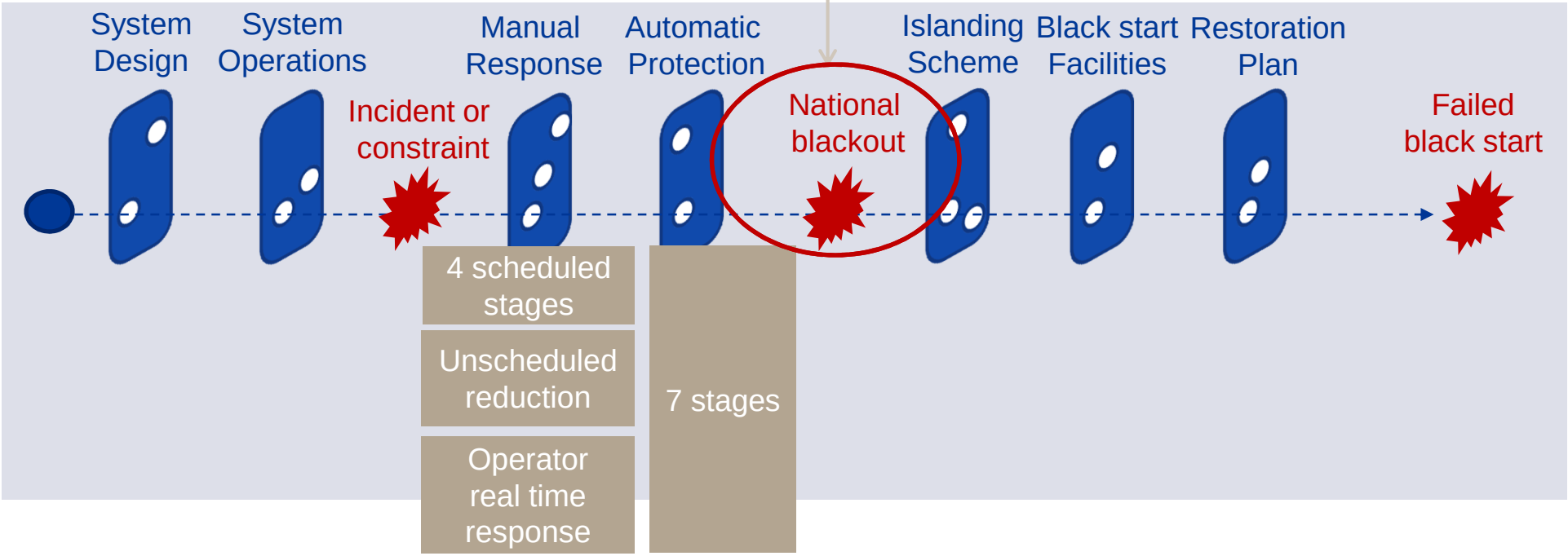


Barrier Discussion & Definition



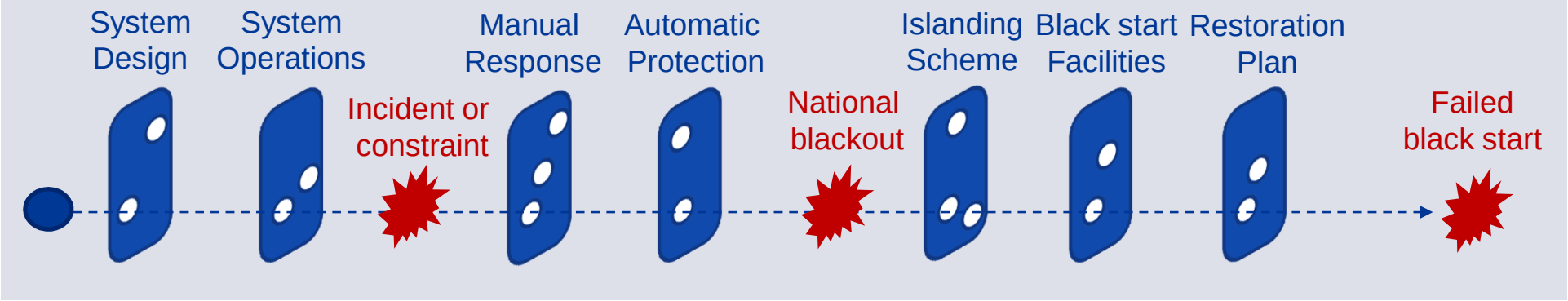
Blackout prevention, response, recovery

Disaster response sector plans:
- Command & control
- Electricity sector (restoration plan) - Eskom
- Security sector
- Critical infrastructure sectors
- Societal sectors
- Communications



NB: Failure is generally related to the failure of several barriers

In summary … blackout prevention



Blackout prevention

1. **Day-to-day operation of the national power system**. The system operator operates the national power system with a primary consideration for the security of the system – in outage planning, management of reserves, and real-time decision making.
2. **Contracted ancillary services**. Eskom has contracted with various customers to manually and automatically reduce demand in response to incidents on the national power system. This is used i.t.o. a Grid Code exemption on reduced operating reserves.
3. **Scheduled demand reduction**. This is executed manually by Eskom's distribution control centres and municipal control centres under the instruction of the System Operator. This includes load shedding and mandatory curtailment by large customers in order to balance supply and demand when all other options are exhausted. The National Code of Practice for emergency load reduction (NRS 048-9) has been developed in order to minimise the impact of emergency load reduction on the country (up to approximately 4000 MW). NERSA has approved use of this Code for proactively managing system constraints.
4. **Unscheduled demand reduction**. Should greater levels of reduction be required to protect the national power system, the System Operator will instruct this as necessary in terms of the National Code of Practice. Critical supplies may not be protected.
5. **Manual load reduction**. This measure will be executed by the System Operator where an incident happens so quickly that load reduction in terms of the National Code of Practice cannot be implemented in time. In this case the System Operator will interrupt supply to some areas as required, until load reduction in terms of the national protocol can be implemented.
6. **Automatic load shedding**: Should the above manual interventions be too slow or inadequate, the national power system has a further seven (7) layers of automatic protection. In recent years, only the first layer of this automatic protection has been triggered at a national level (this happens approximately once a year due to large incidents on the national power system). This has each time operated successfully as designed. The System Operator manages the system so that this barrier is only triggered by unexpected incidents (manual interventions such as load shedding are undertaken to ensure that this is the case).
7. **Additional special protection schemes**. These protection system are designed to protect the national power system against incidents on the transmission system (including those unrelated to a shortage or excess of generation)

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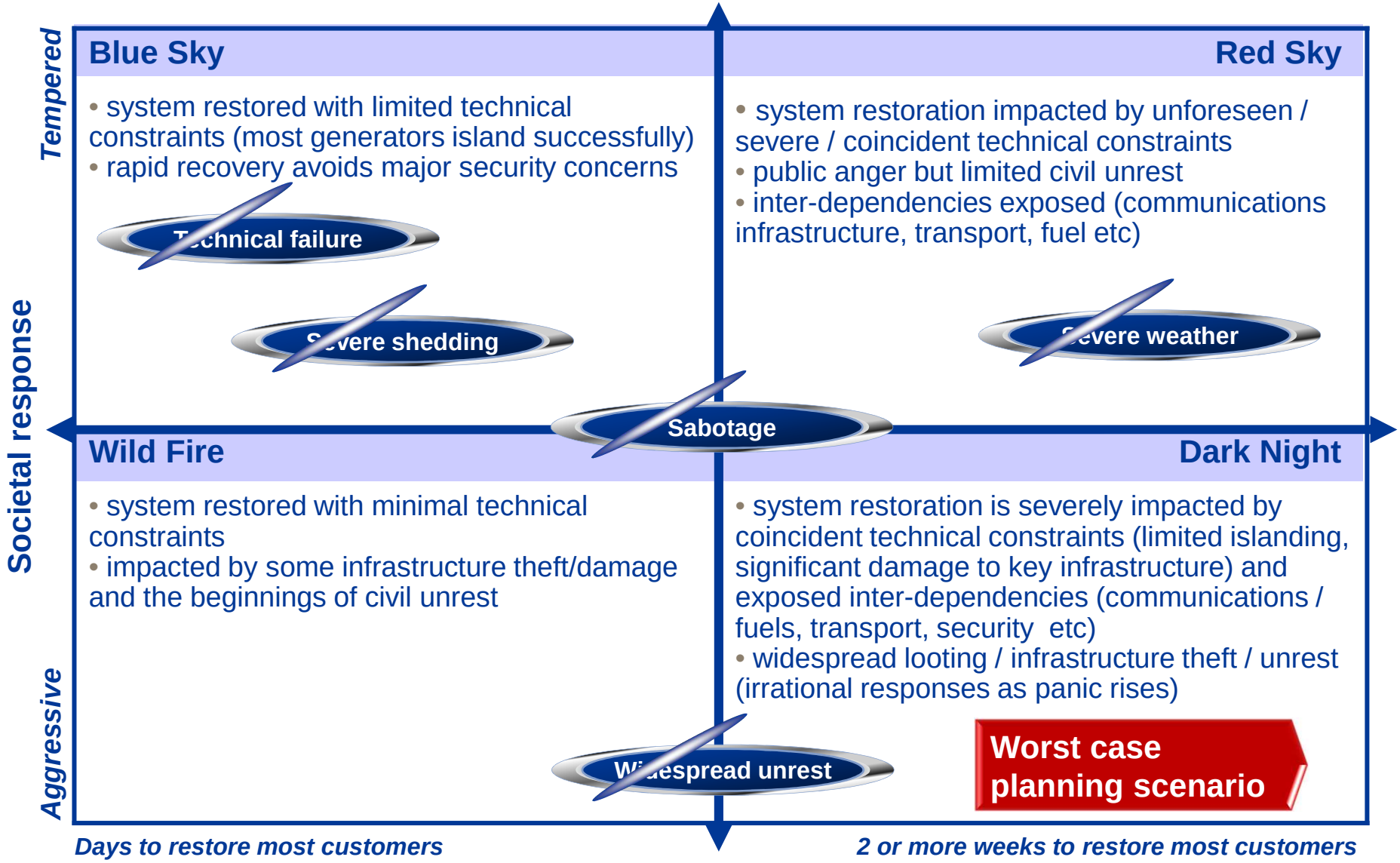
National Blackout Scenario Overview

- **Most likely cause**: an unforeseen sequence of events that results in a cascading collapse of the transmission/generation system, leading to a complete loss of supply across the country.
  - This is a low likelihood, high impact incident. The likelihood of such an event increases when the system is unstable.
  - Whilst the system has multiple defence systems, these can never guarantee that a blackout will be avoided.
- **Warning period**: Such an event can occur with very little (even no) warning. At best, the System Operator may be able to alert the country should the system be at increased risk.
- **Duration**: Restoration of the first loads would take several hours and restoration of the whole system could take multiple days (possibly weeks). This depends on the context at the time.
- **Impact**: Immediate impact on safety, environment, production etc. A cascading impact on national infrastructure (telecommunications, transport, water, sewerage, fuel pipelines, banking, food etc) as back-up supplies are depleted and normal movement is disrupted. Other countries ir the Southern African region will be impacted as well. There is the potential for wide-scale public unrest / vandalism etc. A knock-on effect may be that the supply restoration is impeded.
- **SA uniqueness**: Unlike Europe or North Amerca, there is limited support from electricity networks of neighbouring countries – recovery will depend entirely on internal preparations.

Whilst the likelihood of a provincial/regional may be higher than that of a national blackout, a national blackout is many times more severe than a regional blackout – both in terms of prognosis for recovering the system and impact on emergency resources

National blackout planning scenario



Note: Mapping of causes to restoration scenarios indicative – but any combination is possible

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National Blackout Scenario – System Restoration

- **Priority for the System Operator**: To establish and restore a stable power system using the islanded generation units and/or black start facilities available at the time.
  - The load picked up will be determined by the system operator based on what s best for the stability of the system.
  - The initial priority will not be to supply power to essential and critical loads or specific areas, this is a secondary priority which may take several days and in some cases weeks.
  - This will be done at a pace that has the least risk of resulting in a subsequent blackout.
- **Islands**:
  - Restoration of the national power system will begin in **Gauteng, KZN, and Mpumalanga** in line with the principles indicated above. Loads that will be restored first will be selected based on system requirements.
  - The **Western Cape** may be subject to one of the following scenarios: (i) Remain operating as an island in the event of a national blackout with power supplied by to specific areas allocated by Eskom and the City of Cape Town, (ii) Be blacked-out and a local island re-established with 24hrs with limited available power available allocated by Eskom and the City of Cape Town, (iii) Blacked-out until restoration can occur via the transmission network from the north, which could take several days to be initiated.
  - Other areas will follow, once a stable power system has been established.

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Sector Planning Assumption: Given the above, all sectors and provinces are to assume for planning purposes that a national blackout could result in at least 2 weeks without power to their operations. Longer periods without supply need to be considered, as this cannot be discounted depending on the context under which a national blackout occurs

Restoration times (best case scenario!)

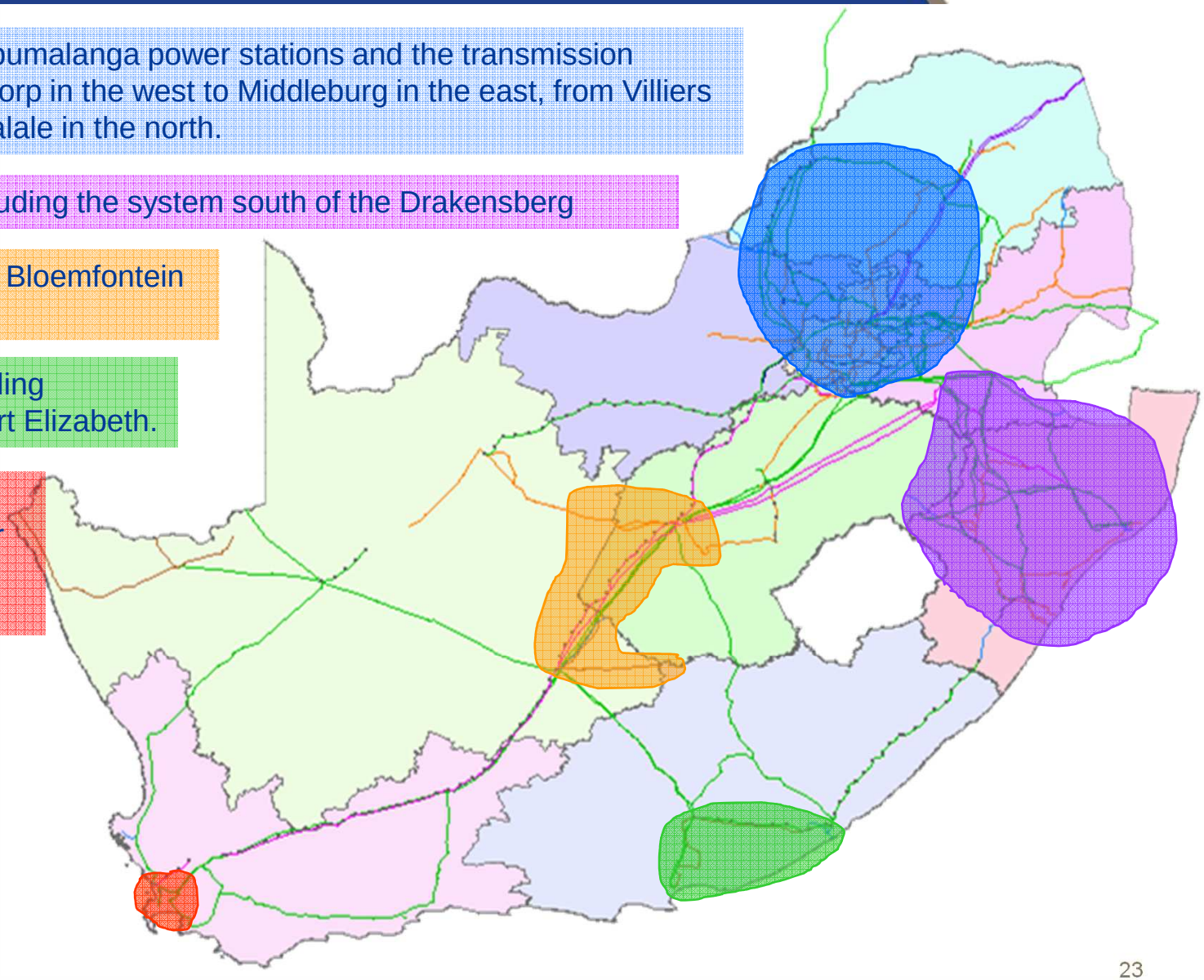
- Restarting the power system from **islanded units is significantly faster** than black starting the power system using the black start facilities due to the units already being on load and supplying their own auxiliaries.
- **Following a complete blackout** of the grid, at least **one** black start facility is required to restart the power system.
- The longer a **coal fired generator** has been shut down, the longer it takes to restart the unit.

Condition	Generator off	Restart time
Hot start	2 – 4 hours	4 hours
Warm start	4 – 10 hours	6 hours
Cold start	> 10 hours	> 16 hours

- It is estimated that full restoration (completely energised Transmission network loaded to ~30 GW) will take 6 – 14 days (best case scenario).

Transmission plan (Five islands)

- **Central** including Mpumalanga power stations and the transmission system from Klerksdorp in the west to Middleburg in the east, from Villiers in the south to Lephalale in the north.
- **Kwa Zulu Natal** including the system south of the Drakensberg
- **Free State** including Bloemfontein and Kimberley.
- **Eastern Cape** including
- East London and Port Elizabeth.
- **Western Cape** including local power stations and the peninsula



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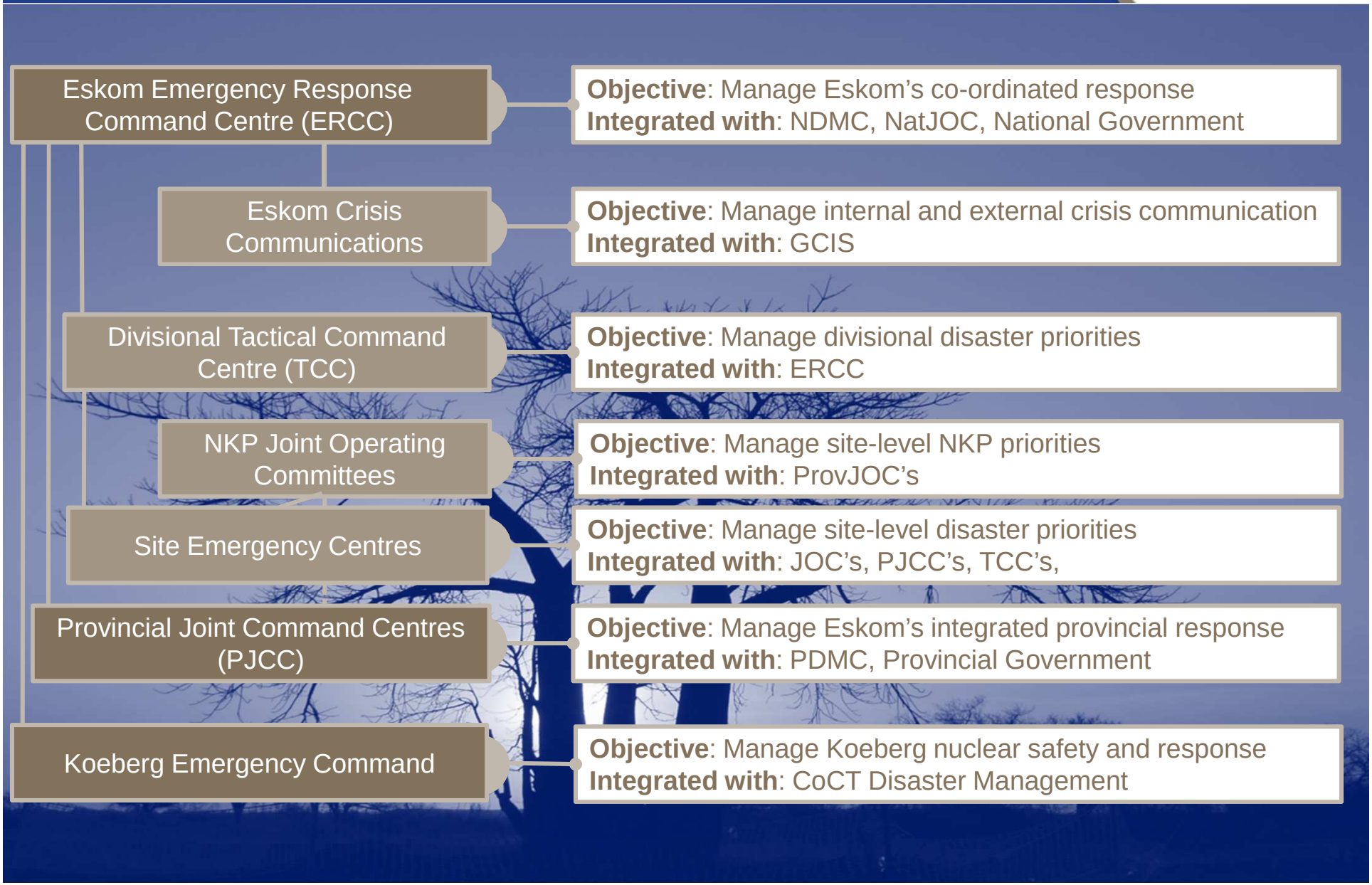
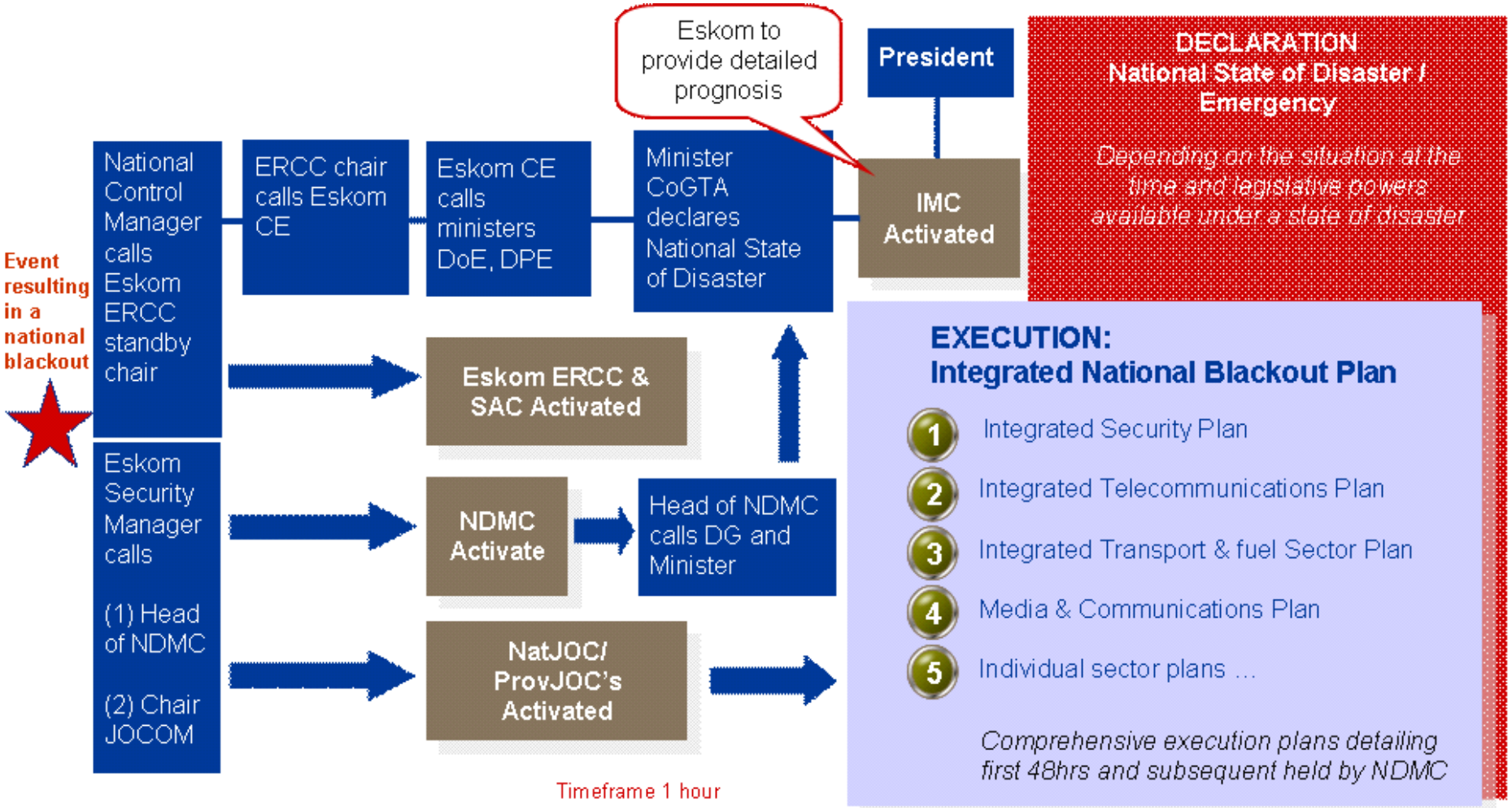
Eskom's integrated response structures



Activation of national response structures



EXECUTION: National Black Start System Restoration Plan

Comprehensive plan held by the National System Operator

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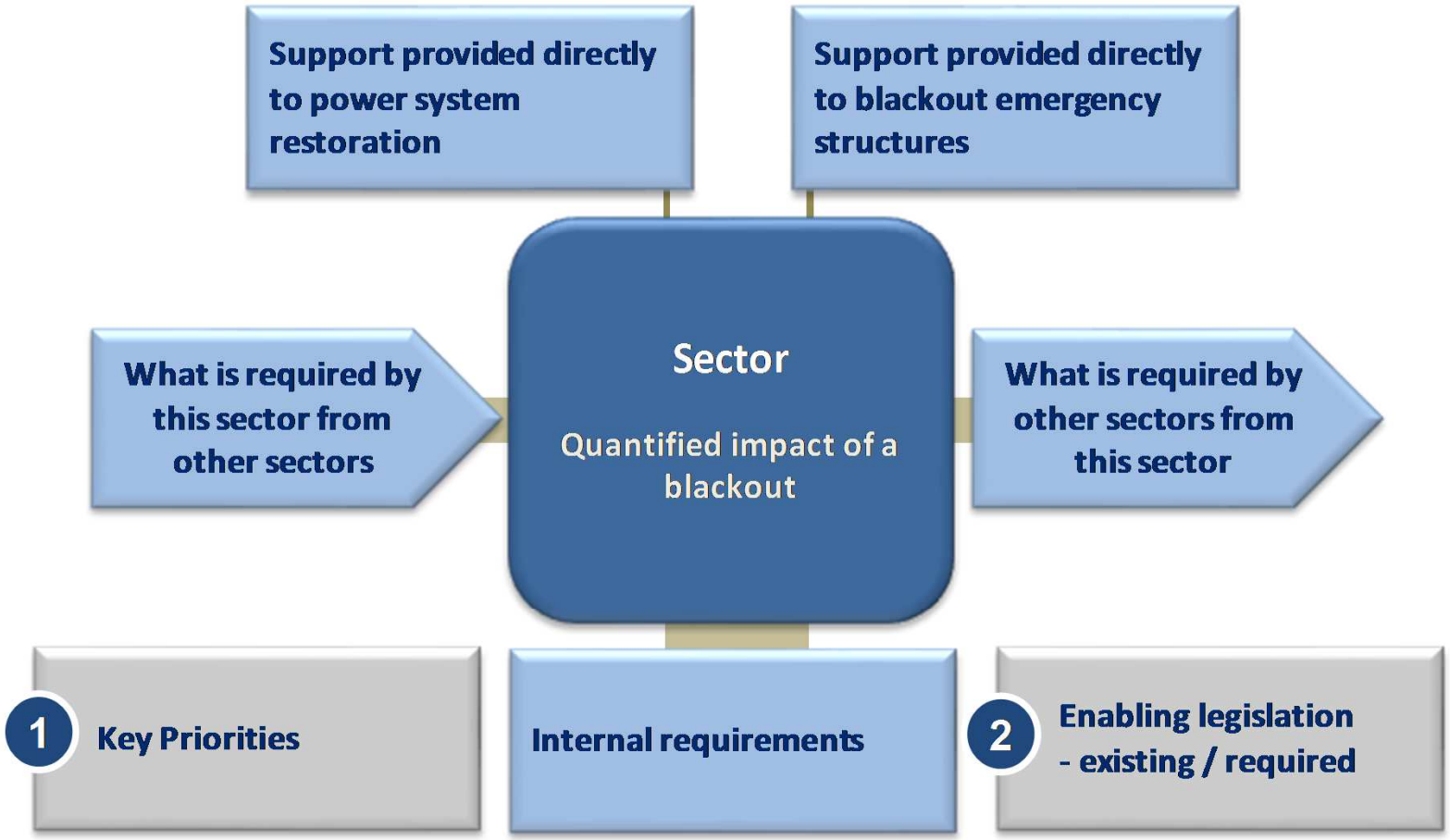
Sector planning



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2 Sector mandate and priorities

Sector Mandate : xxxxx

Preparedness Priorities	Response & Recovery Priorities
Examples • B….	Examples: • S…

Sector impact and legislative context

4 Impact of the disaster on the sector

- Xxx

5 Applicable legislation, policy, procedures

- Xxxx
- …

3 Sector response: roles & responsibilities

In Support of Power System Restoration	In support of sector resilience/response (*Emergency response, business continuity, safety*)
• Xxx (Responsible role: xxx)	• Xxxx (Responsible role: xxx) • • …

3 Sector integration: country plan

Support required from other sectors	Support provided to other sectors
• Xxx (Sector)	• Xxx (Division(s))

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Conclusions

- Eskom's core accountability is the prevention of a blackout, and readiness to restore the national power system should such an incident occur.
- Load shedding does not bring the system closer to a blackout. It is a prudent measure to manage the system from increased risk of a blackout.
- Eskom has established an internal project to enhance its integrated response as a company.

Going forward:

- The NDMC (supported by the NatJoints) is overseeing the integrated national plan.
- Eskom is currently engaging with sectors – but this should ideally be in the context of the national project.
- The template provides a helpful tool for ensuring that common assumptions are used.
- Given the many interactions, a project management team is recommended, over and above the steering committee.