National Blackout Awareness

Siju Joseph

System Operator – Eskom Transmission

Introduction

- **Objectives**:

- To provide insight into the concept of a power system blackout
- To address Eskom's core mandate of preventing a blackout, readiness to respond, and restoration of the national power system.
- To provide stakeholders a view of the national response from a load perspective

This is in the context of power system contingency planning for extreme events as required by the South African Grid Code and Disaster Management Act

Major failure of the power system

Early warning: Notice of a national blackout will be limited (most likely, none at all).

The onset will be infinitely more rapid than disasters such as the pandemic.

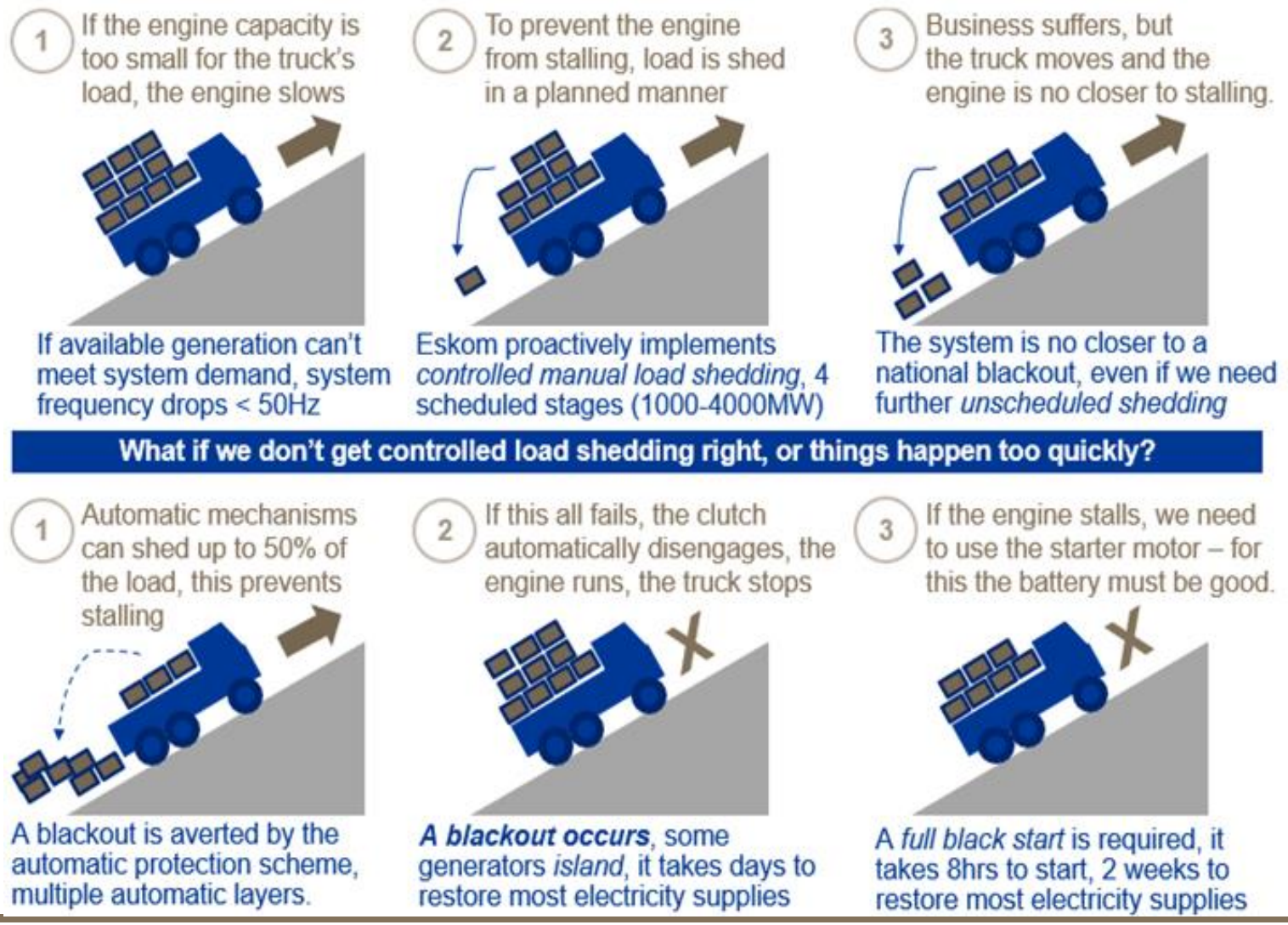
Load shedding: Does not increase the risk of a national blackout; it is implemented to prevent a national blackout.

Terminology - general

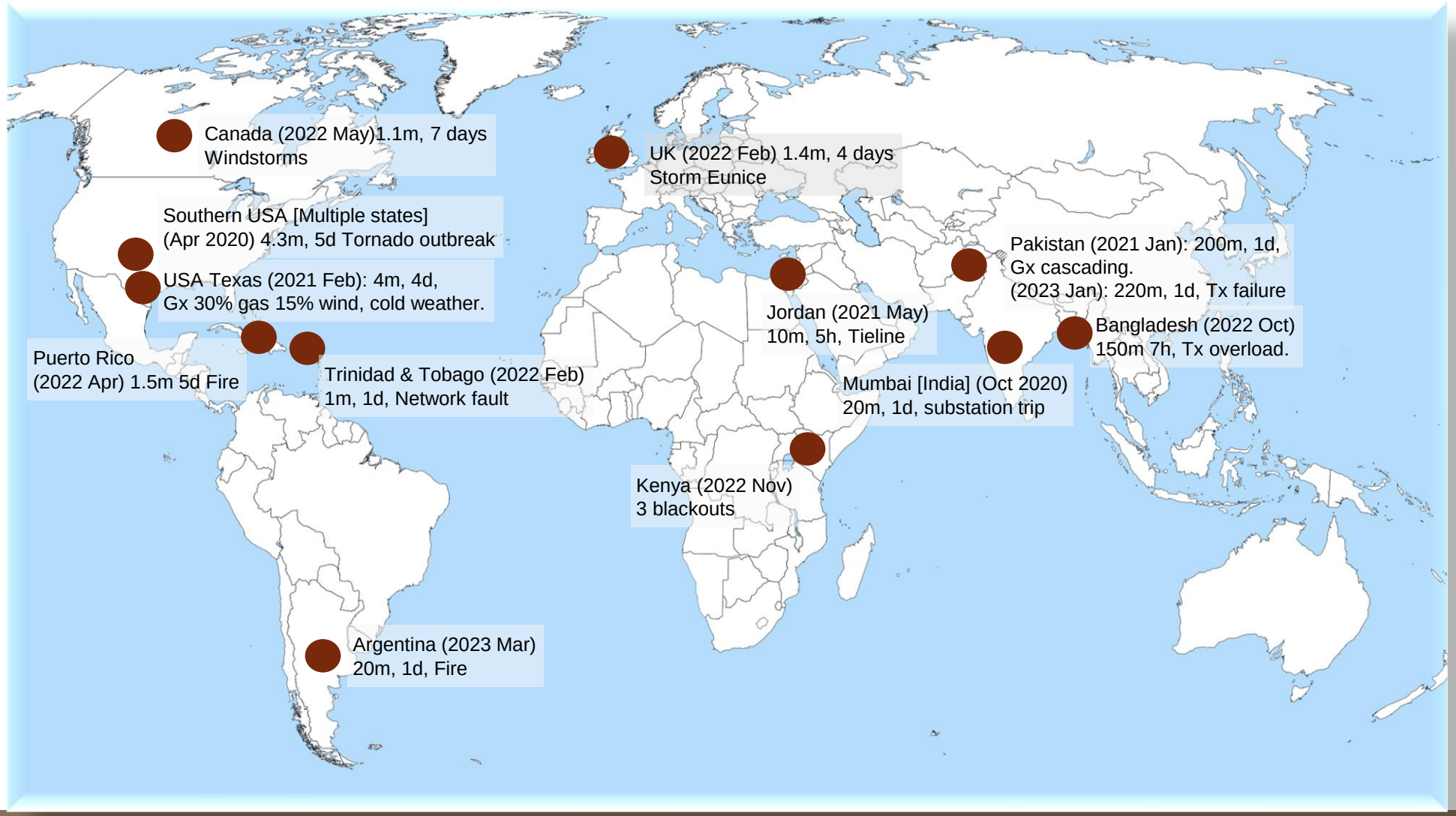
Interruption of supply	Separation of a customer or group of customers from the Interconnected Power System (“grid”). Usually localized.
Load shedding	Controlled rotational interruption of supply in order to prevent a complete blackout of the power system
Regional / area blackout	Uncontrolled separation 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 energized and stable with generators in the island supplying customers in the island.
National blackout	The complete, uncontrolled, de-energisation of the power system. Generators may “island to house load”. All customers lose supply.

The fragility of a power system

- The South African power system can be thought of as **one big machine** all the way from Matimba in the north to Koeberg in the west.
- This “machine” is made of many pieces of equipment, failure of which could result in it affecting stability of the network.
- Technical causes of blackouts from this “machine "could include frequency imbalance, voltage stability issues etc.
- Load shedding is a tool used by the System Operator to ensure supply- demand balance.



Notable International Regional and National Blackouts (2020-2023)



Notable International Regional and National Blackouts (2020-2023)

Area	Date	Duration (days)	Affected (millions)	Cause
Southern USA	April 2020	5	4.3	Tornadoes
Mumbai, India	October 2020	1	20	Substation trip
Pakistan	January 2021	1	200	Gx cascading
Texas, USA	February 2021	4	4	Snowstorm
Jordan	May 2021	1	10	Tie-line trip
Southern UK	February 2022	4	1.4	Storm Eunice
Trinidad & Tobago	February 2022	1	1	Network fault
Puerto Rico	April 2022	5	1.5	Fire
Quebec, Canada	May 2022	7	1.1	Derecho (windstorm)
Bangladesh	October 2022	1	150	Tx overload
Pakistan	January 2023	1	220	Tx failure
Argentina	March 2023	1	20	Fire

- These are the blackouts that occurred this decade.
- 2023 has so far seen major blackouts in Ghana and Pakistan.
- Note the variety of causes

A few key impacts of a national blackout

Telecommunications

- Mobile sites will be sustained 2-4hrs (*what about traffic & priority access*)
- **Backbone** failure within 8hrs
- Recharging batteries
- Other **South African Telco's** will not be available after a while

Water

- **Local reserve 48hr** guideline for munics (not universally in place)
- **Water treatment** essential (cannot distribute raw water)
- Water required for **data centres**
- Power stations may have min 3 days (for 6 units) // downstream flooding

No MS TEAMS?

Liquid fuel

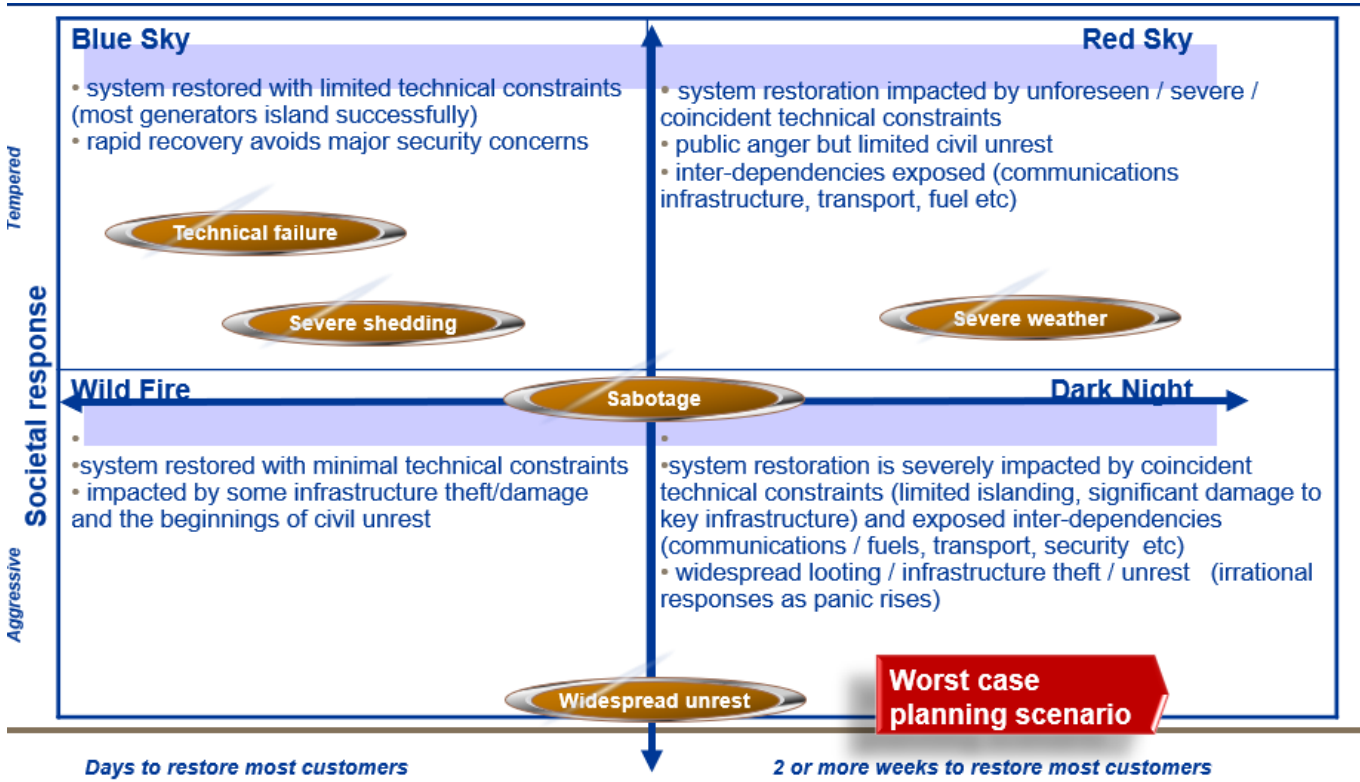
- Storage available "3-5 days" subject to requirements (no backup gens)
- **Ports and refineries** need electricity (No contingency plans)
- Industry will be required to ration and prioritise supply

Security

- Sectors cannot rely on **national security** structures (limited resources)
- **Correctional services** – generators only 24hrs not adequate capacity
- International experience have shown **widespread looting** during a blackout

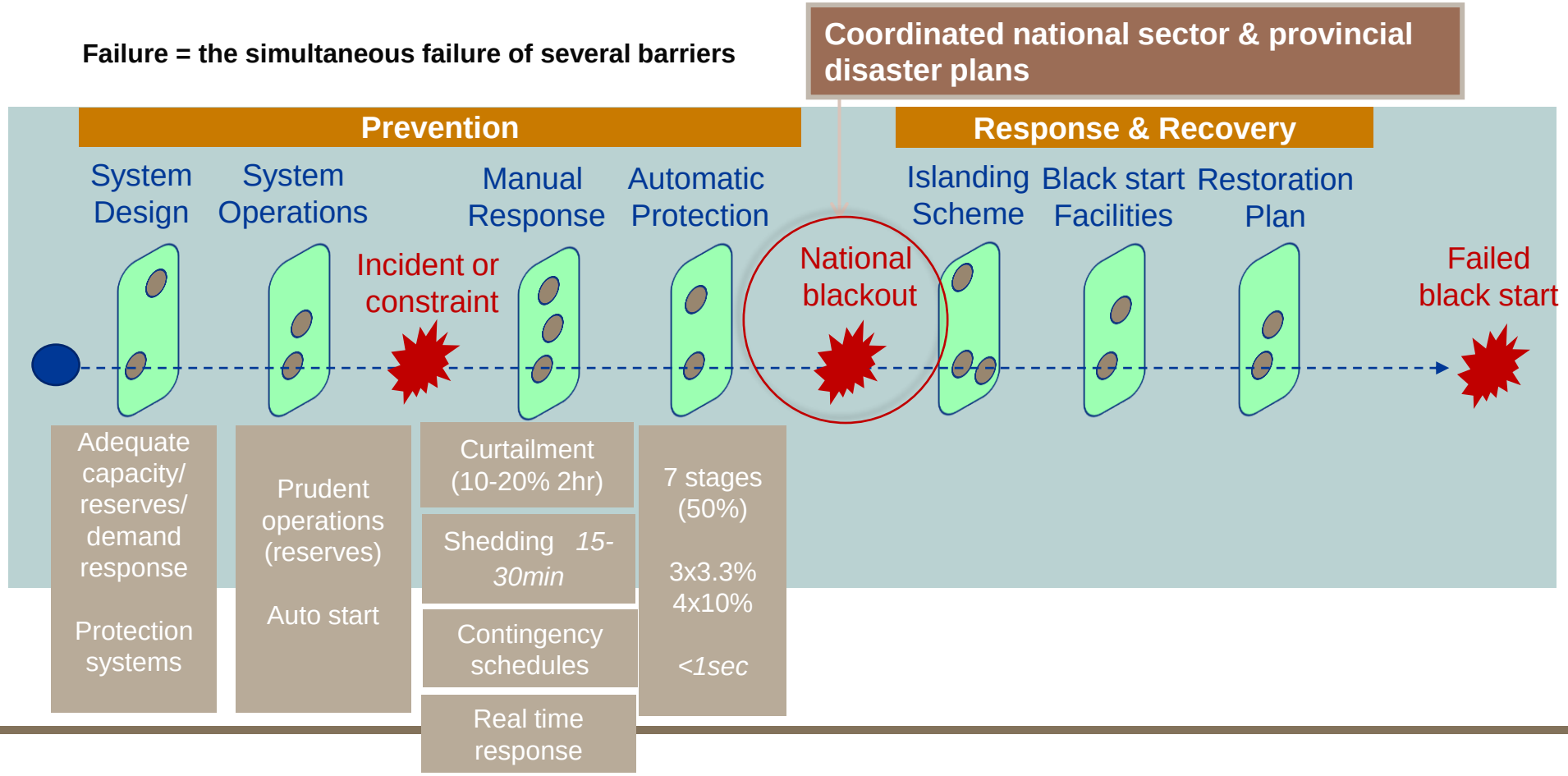
National Blackout context

- **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
- **Warning period**
  - **Little-to-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 occur after several hours and restoration of the whole system could take multiple days **(possibly weeks**). This is dependent on the root cause and prevailing conditions
- **Unique South African challenges**
  - A large **centralized** power generation pool
  - A large geographically distributed customer base separated **by very long transmission lines**
  - The smaller size of the power systems in neighbouring countries in comparison to South Africa and **weak interconnections** that South Africa shares with these smaller neighbouring countries
  - The strong likelihood that a South African blackout may cause corresponding blackouts in neighbouring countries



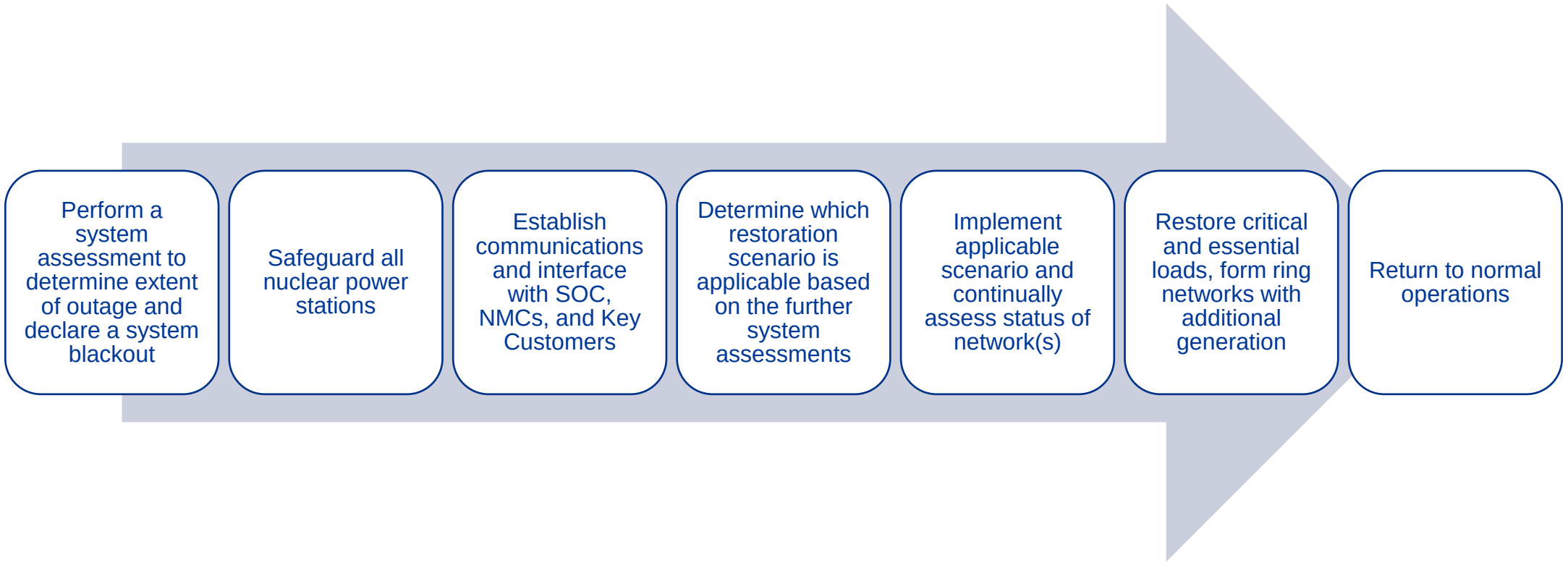
Blackout prevention, response, recovery

A low likelihood incident: multiple layers of protection are in place to prevent a blackout

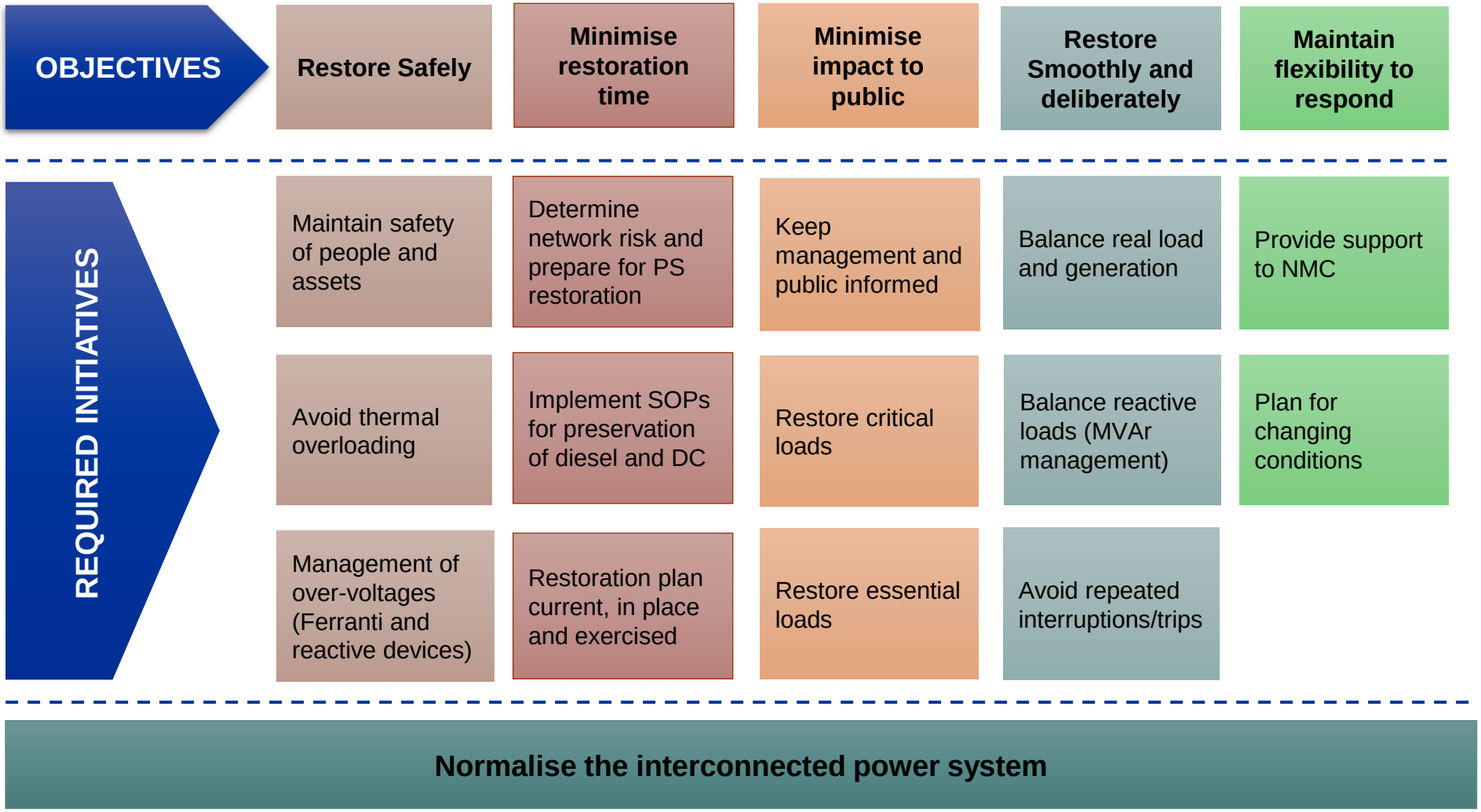


High Level Restoration Strategy

- From the System Operator perspective, the following high-level responsibilities form part of the overall strategy in response to a blackout.
- Throughout all phases, System Operator will be responsible for disseminating timeous and accurate information pertaining to the restoration process to the rest of the business



Load Restoration Objectives



Load Restoration Guideline

1st Phase

System restoration

- *Stability is of concern*
- *Support system restoration*
- *Restore enabling requirements*

PRIORITY 1

1. ***Resistive load:*** *Municipalities, Metropolitan Municipalities and Eskom Loads*
2. ***Enabling requirements:*** *DMS (SCADA), DCS, Back-up DMS and DCS, ERCC, PJCCs, PEoC, EoCs, IGCC, EP Centers, MWP, Telecommunication infrastructure, Data Centre, Schools and Community halls, Police, SANDF etc.*
3. ***Other considerations:*** *DWAF, Pumping stations, P/S unit supplies, P/S auxiliary and essential services, Oil refineries, Hospitals and Sewerage supplies etc.*

2nd Phase

Load restoration

- *Islands formed*
- *Other P/S connected*
- *Tx & Dx networks meshed, and n-1 firm*

PRIORITY 2

1. ***Bulk supply customers:*** *Municipalities, Metropolitan Municipalities and Eskom Loads*
2. ***Key Stakeholders:*** *CNCs; Resource management; Contact Centers; Regional head offices; Power station office blocks; National, Provincial, Metro and District DMCs, Equipment stores, etc.*
3. ***Other considerations:*** *Agricultural and Commercial loads (Airports, Top Customer house load and auxiliaries, SABC, Banking sector, Retail sector, SENTEC towers, etc.)*

3rd Phase

Load recovery

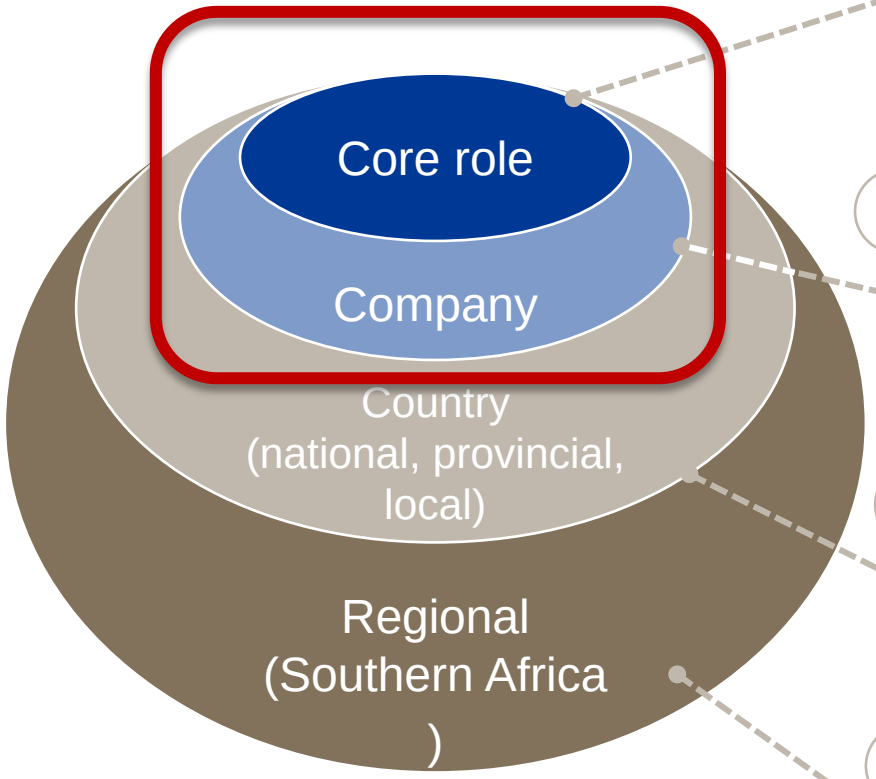
- *Stable islands formed*
- *Other areas are considered*

PRIORITY 3

1. ***Industry load:*** *Mining (Coal, Platinum, Gold etc.), Steel, Manufacturing, etc.*
2. ***Key stakeholders:*** *Walk in centers, Local offices, Conference centers etc.; Distributed energy resources, Co-gen, etc.*
3. ***SAPP/SADC:*** *Lesotho, Mozambique, Namibia, Botswana, Zambia, Zimbabwe etc.*

Key roles in a blackout _ A load perspective

Sector Disaster Management Roles



1 **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

3 **Collaborative planning and response:**
- National, provincial, municipal disaster structures
- National sector departments and organs of state
- National/provincial crisis communications
- Stakeholders

4 **Collaborative planning and response:**
- South African Power Pool joint planning
- Support to the NDMC in engaging SADC countries

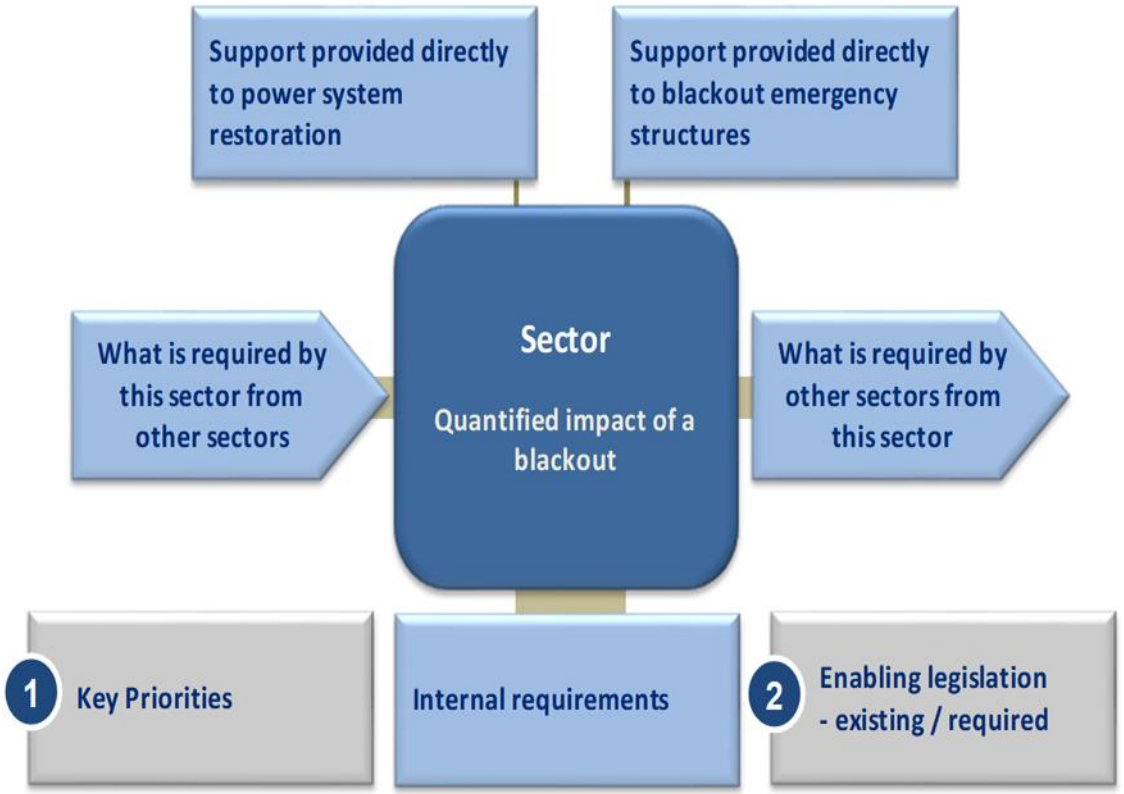
(South African Power Pool, NDMC)

Possible improvements to current process -Customer role in a blackout

- It is assumed that all customers have, and will follow their **internal emergency preparedness plans** while **taking instruction from Eskom** regarding the restoration process
- In order to assist with the restoration process, the System Operator would require **customer technical information ahead of time** to verify if a customer can be used to **safely load generators** without risking the restoration process:
  - Location of customer (geographically and electrically)
  - Load size, load type and industrial process
  - Load characteristics upon start-up, during run-up to full load and during normal operation (e.g., load values at key stages, minimum/maximum ramp rates, transients, etc.)
  - Any specialised protection schemes installed that are not visible to Eskom (e.g., frequency, voltage, etc.)
  - Constraints (human and plant risks, operational limits, etc.)
  - Maximum and/or minimum time off or on
- Those customers that are located on a critical restoration path **and** have suitable load characteristics and values can be incorporated in the restoration plan as a **potential** source of load in the initial restoration process.
- Identified customers will be engaged individually to firm up on prospective plans and requirements
- All other customers will be prioritised as per the Load Restoration Guideline i.e., they will receive power after there is an established ring network(s) with multiple generators synchronised

Customer communication preparation

- As stated earlier, each customer has the **responsibility** to ensure that they have their **own internal Disaster Management and/or Emergency Preparedness plans**
- As a minimum, **irrespective of the load restoration prioritisation**, the teams need to work together to answer the following important questions:
  - Who is your **contact person/point** for situational awareness? (Municipality, Distribution, etc.)
  - Is this contact aware of your interdependence on them for **two-way communication** regarding the restoration process?
  - What will be your primary and secondary **means of communication** during the national emergency? (Fixed line, mobile network, satellite phone, etc.)
  - Are your means of communication aligned with your contact person/point above?



Conclusions

1. **Eskom Disaster Plan:** In place, updated annually (*incl. 11 national disasters*)
2. **Blackout:** This remains a low-likelihood, high-impact incident
3. **Early warning**: Most likely none, though some conditions increase risk
4. **Load shedding**: Stages 1-8 in place as risk reduction measures (Review underway)
5. **Blackout restoration plan:** In place, exercised, risks monitored (Eskom Board level)
6. **Restoration**: Deliberate, not focused on critical loads (focus is avoiding a 2nd failure)
7. **Eskom contingency planning:** In place, continually being improved.
8. **Country plan: Not in place**.