The Greenhouse Gas Effect on Climate Change and the Impact on Electricity Supply and Infrastructure – A Systems Thinking Approach

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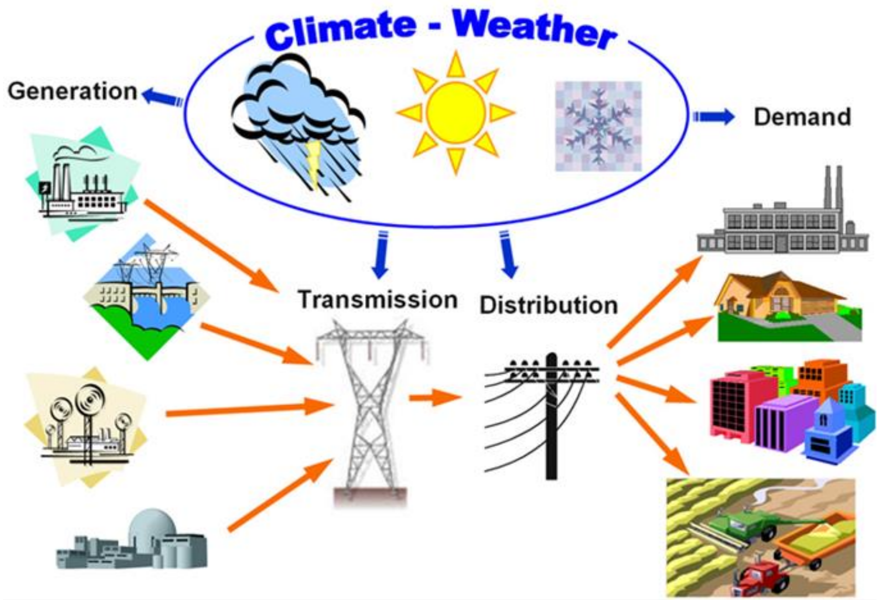
Background and Introduction

- Fossil fuels such as coal, oil and gas are by far the largest contributors to global climate change.
- They account for over 75% of global greenhouse gas (GHG) emissions and nearly 90% of all carbon dioxide emissions.
- Over 90% of South Africa's electricity is generated using fossil fuels and the cars use petrol or diesel as there are not yet many electric vehicles in the country.
- As greenhouse gas emissions blanket the earth, they trap the sun's heat leading to global warming and climate change in a form of extreme weather changes.
- Global warming is the rise in atmospheric temperature (by 1.5 ºC) due to increased GHG emissions over the years,
- There is a rise in sea levels and change in precipitation patterns leading to more extreme weather events such as flooding, wildfires, extreme cold(snow), heatwaves, drought etc.



Climate Change Risks and Impact on the Electricity Generation

- Generation division is also impacted by the risks of climate change such as extreme weather events.
- The main events to be illustrated are drought and heavy precipitation which leads to flooding.
- Extreme rainfall refers to more than 20mm of rainfall within 24 hours over an area of 64km2.
- Drought is a prolonged dry period that can be caused by increased dry spell days and heat waves resulting in water shortages.

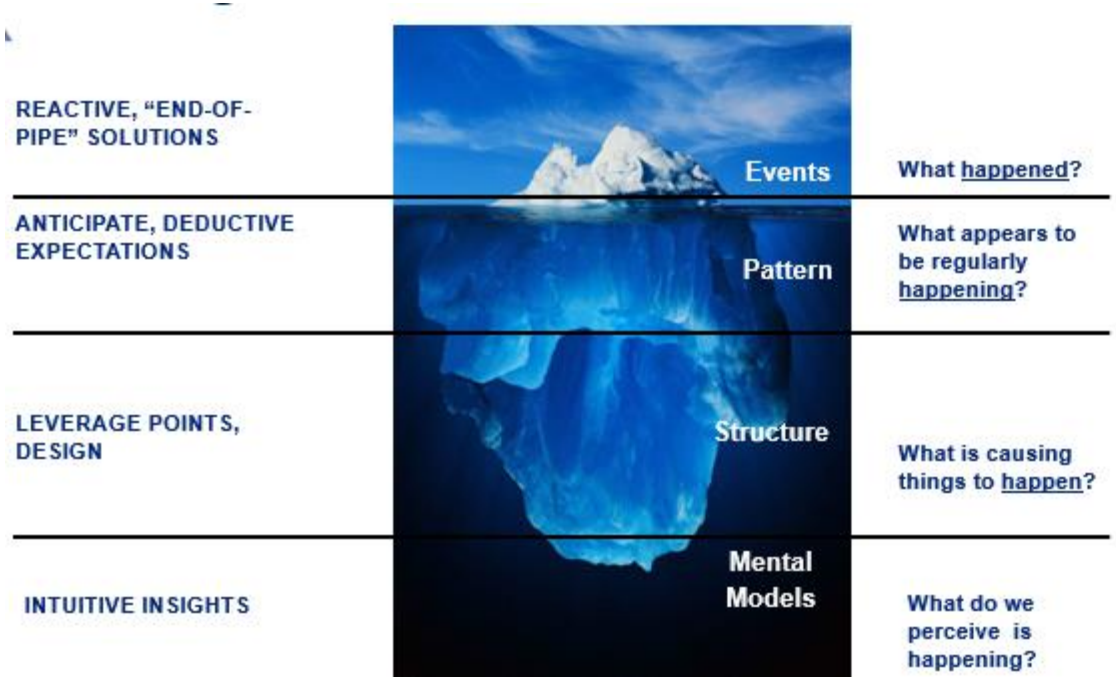
Climate Change Variable	Associated Risk on Generation	Mitigation Strategies
Dry Spells/ Drought	Reduced access to water resources Emission reduction challenges Impacts on operations and projects	Increase water storage at sites Maintain water treatment facilities Implement emission reduction strategies
Heat Waves and Very Hot days	Impact on cooling systems Impact on human performance	Application of cooling technologies Work-stoppage as per risk assessment
High fire danger days	Veld fires	Implement fire management plans Integrated disaster management plan
Heavy Rainfall	Flooding and spillages Ash dam collapse Interrupted operations, coal supply	Optimal design and maintenance of storm water systems. Water reuse – prevent water from contamination Ash dam risk assessments to be conducted.

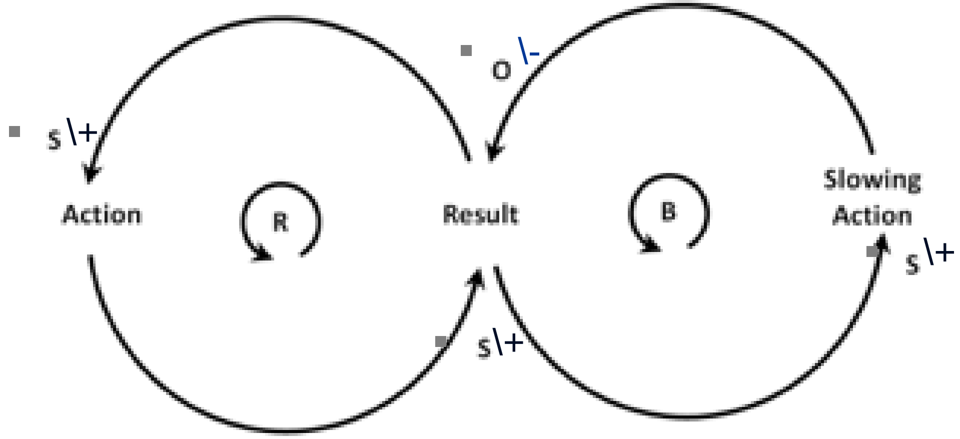
Extreme Weather Impact on the Electricity Transmission & Distribution

- Transmission operations, infrastructure and assets span across the South African landscape.
- They are vulnerable to chronic and acute changes in climate albeit contributing to greenhouse gas (GHGs) emissions.
- In areas where the electricity systems are exposed to significant risks driven by climate change this could result in serious impacts to grid stability, supply of electricity and employees.
- Adaptation measures must be in place to reduce the vulnerability of systems to the impacts of climate change.
- Distribution’s activities of operating electric equipment also leads to GHSs affecting the environment and humans.
- The climate adaptation plan includes:
  - Build climate resilience and adaptive capacity to respond to climate change
  - Ensure resources and systems are in place to enable implementation of climate change responses.

Systems Thinking Approaches

- Relates to the principle of understanding how the *various physical elements* and behavioural agents in a system *influence* one another.
- Understanding of systems lies in the structure or causal relations between the system parameters
- This presentation addresses two techniques, the Iceberg Model and the Causal loop Diagrams.
- The Iceberg Model is a tool that helps individuals discover the underlying structures supporting a particular problem.
- Causal Loop Diagram (CLD) consists of arrows connecting variables in a way that shows how one variable affects the other.





Diving Deeper with the Iceberg

Problem:

Transmission Line Burnt

Why did the transmission line burn?

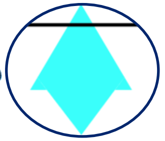
What actually happened?
The facts

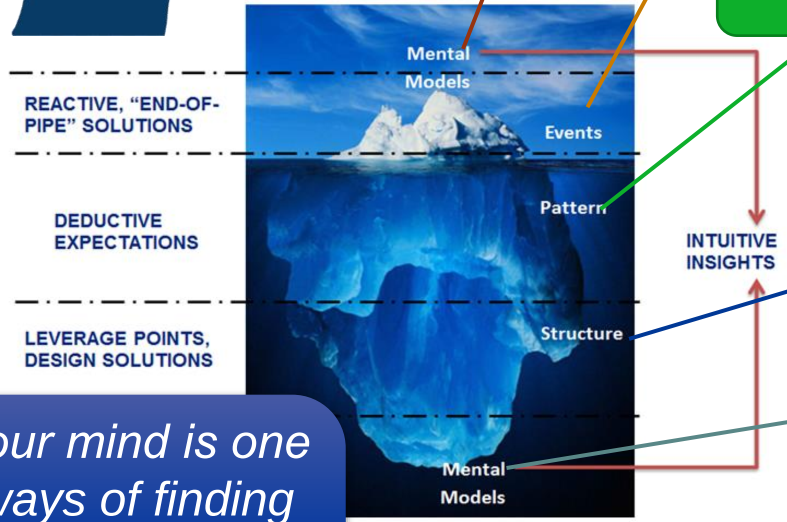
What has been happening? What similar things have been taking place?

What forces are behind the patterns? What policies, structures or drivers are creating these patterns?

How are we thinking about this, that is keeping the structures in place?

Mental Models

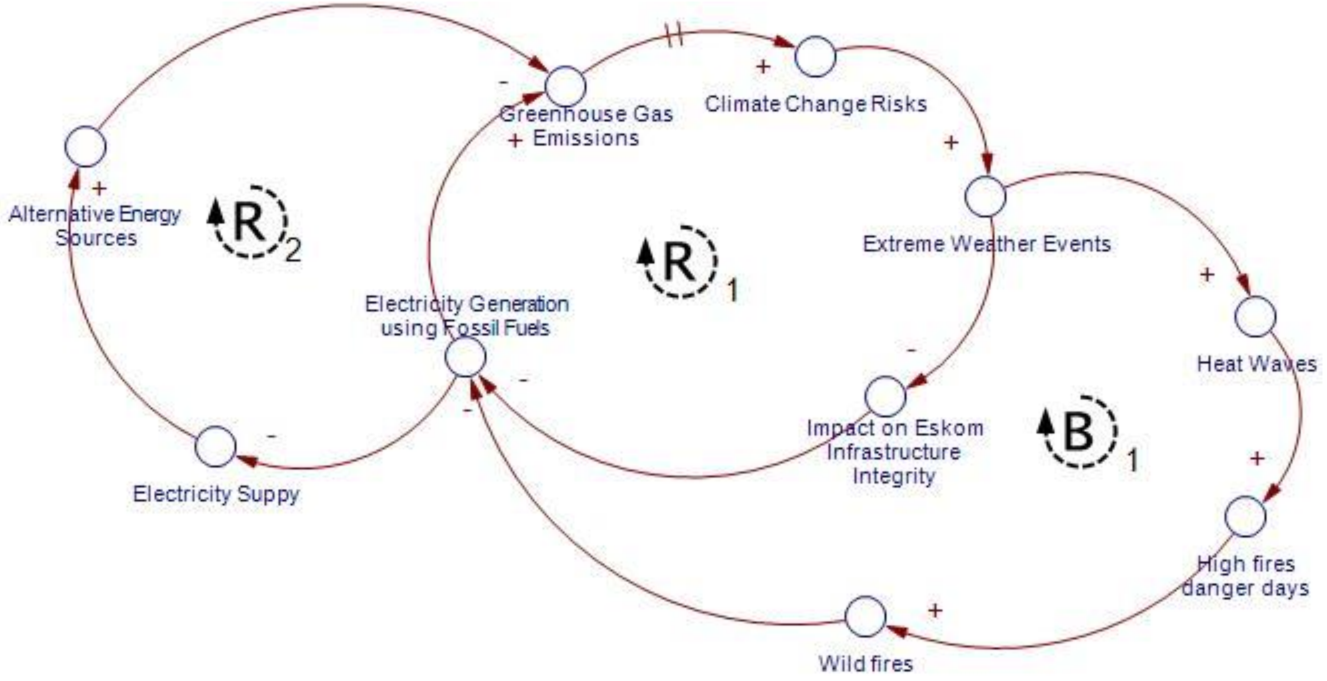




"Changing your mind is one of the best ways of finding out whether or not you still have one"
Taylor Mali

Causal Loop Diagram

- A causal loop diagram maps the cause-effect interdependent variables within the system
- A reinforcing loop shows change in one direction re-inforcing the problem
- A balancing loop has a counter change in the opposite direction to bring the desired state



- Reinforcing Loop R_1 – Climate change due to greenhouse gases
- Reinforcing Loop R_2 – Relief brought by alternative energy sources on greenhouse gases and overall climate change
- Balancing Loop B_1 – Impact of extreme weather on Electricity Generation

Mitigation and Adaptation Strategies

Mitigation Strategies

- To reduce the adverse effects from climate change, the organization must implement adaptation and mitigation strategies
- The Just Energy Transition is one of the strategies that Eskom is using to move away from coal fired power to renewables
  - Accelerate repowering of power stations with lower carbon technologies
  - Re-purpose power plants with innovative non-power options through partnerships
  - Strive to achieve net-zero emissions by introducing renewables such as battery energy storage, microgrids, solar panels, etd.
  - Accelerate grid strengthening and extending the transmission and distribution network

Adaptation Strategies

- An Integrated Risk and Resilience Management procedure for adaptation to climate change has been compiled
- It provides a step-by-step guide on how to manage the adverse impacts extreme weather changes.
- The SA government has a set of regulatory requirements which include the National Development plan
- The plan has a set of indicators for natural resources, accompanied by publication of annual reports on the health of identified resources to inform policy.
- The plan aims for zero emission building standards by 2030.
- Build a resilience infrastructure that can withstand the adverse weather conditions.

Conclusion