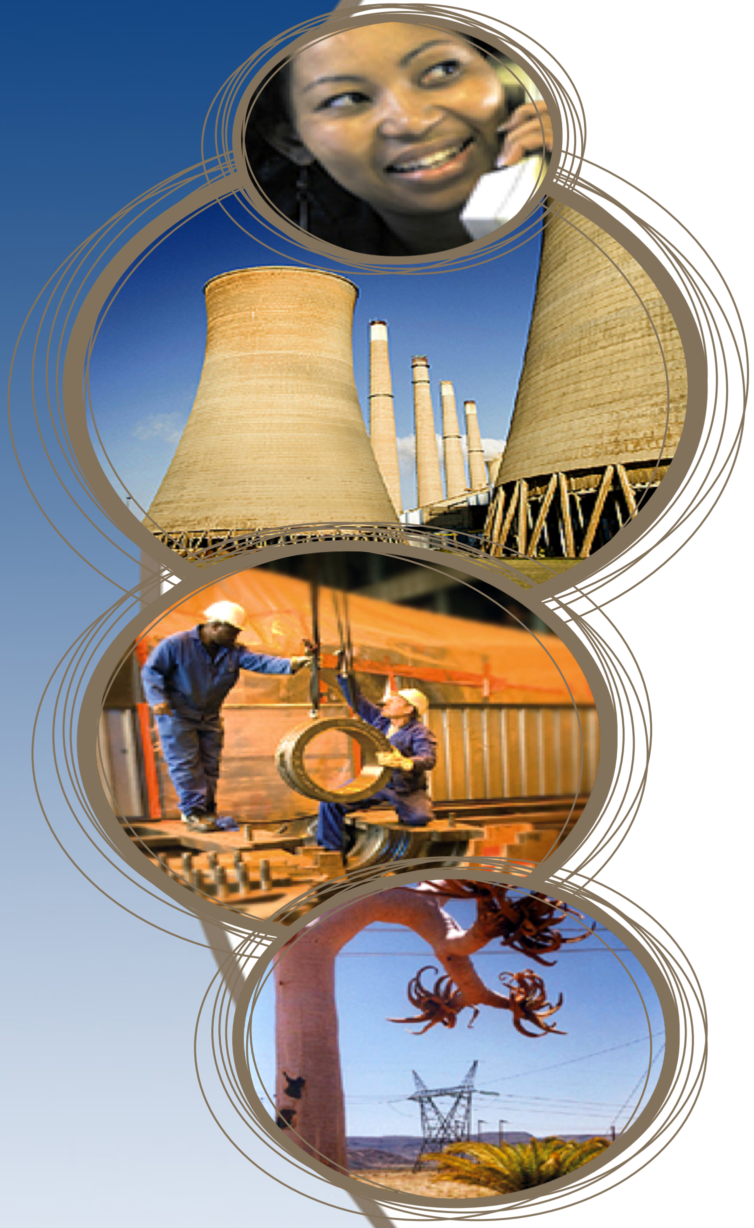

Bulk Energy Storage Integration – Planning Studies

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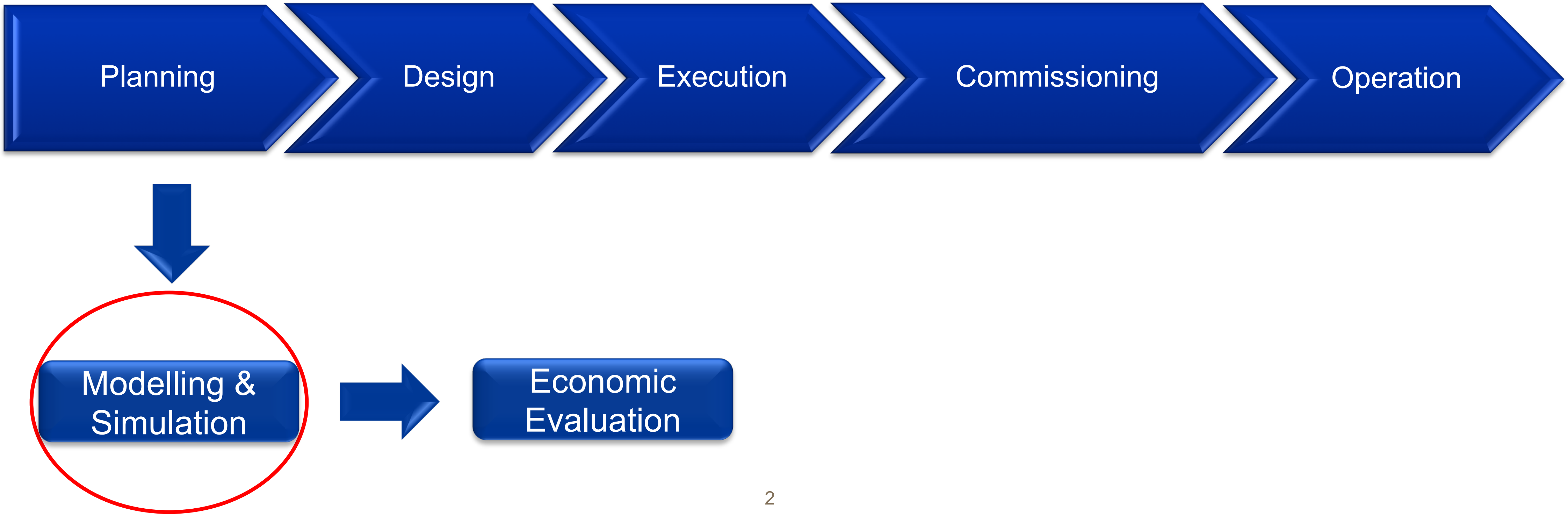
Group Technology - Planning CoE

Seminar: SAIEE, Sandton ICC

Date: 28 November 2019

Introduction

- Bulk Battery Energy Storage (BES) is envisaged as a key enabler of the future energy landscape
- This presentation shares the network planning philosophy which was developed for the modelling and simulation of BES, including a case study.



Modelling & Simulation

STEP 1

Data Collection, Review and Validation:

- Network topology (existing and future models);
- Network generation and loading data (historical and forecasted).

STEP 2

Network Constraint Study & Use Case Selection:

- Existing network constraints;
- Simulation of future constraints (e.g. voltage & loading);
- BESS application Identification.

STEP 3

Preliminary BESS Size Identification & Static Load Flow Studies:

- BESS size (MW : MWh) to resolve network constraint(s);
- Static Power flow studies to test network operational limits.

STEP 4

BESS Operation & Characteristic Modelling:

- Storage characteristics model;
- Storage charge/ discharge profile;
- Storage utilisation statistics.

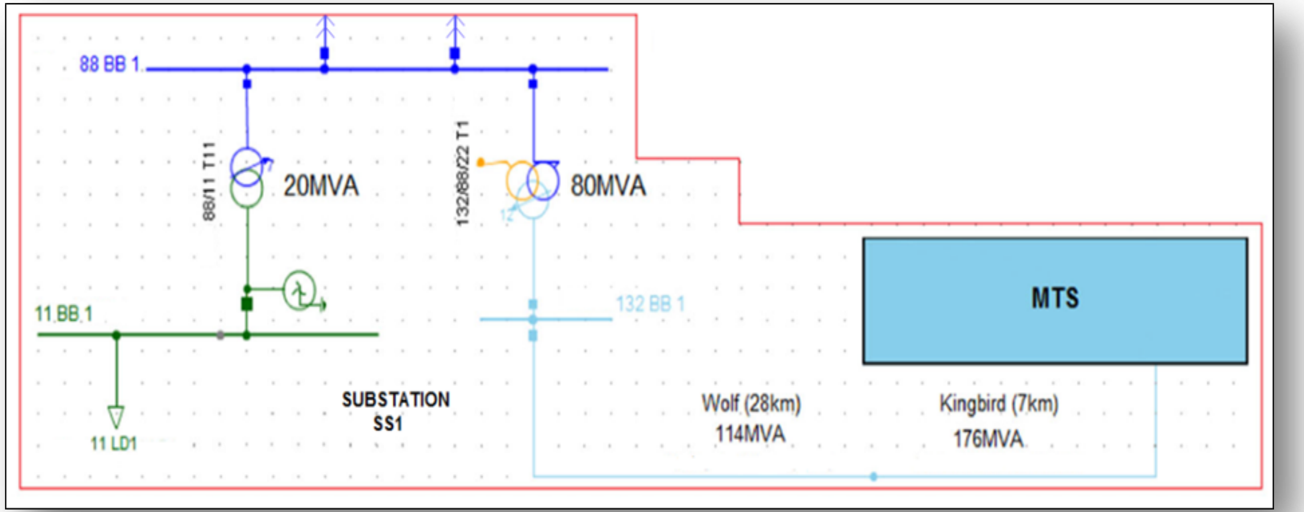
STEP 5

Power System Analysis of the BESS:

- Temporal QDS simulation to test voltage and thermal loading of network;
- Confirmation of the BESS effectiveness

Case Study

A)



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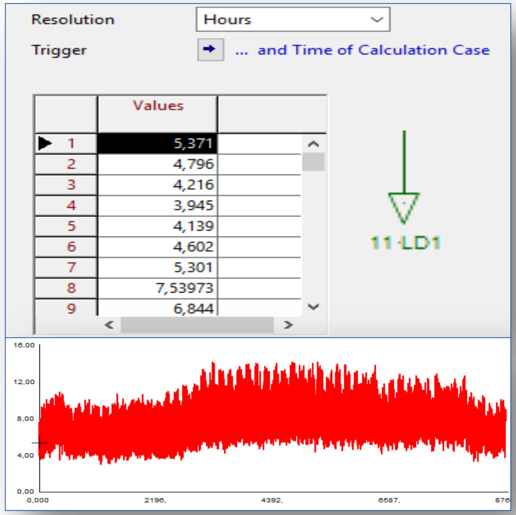

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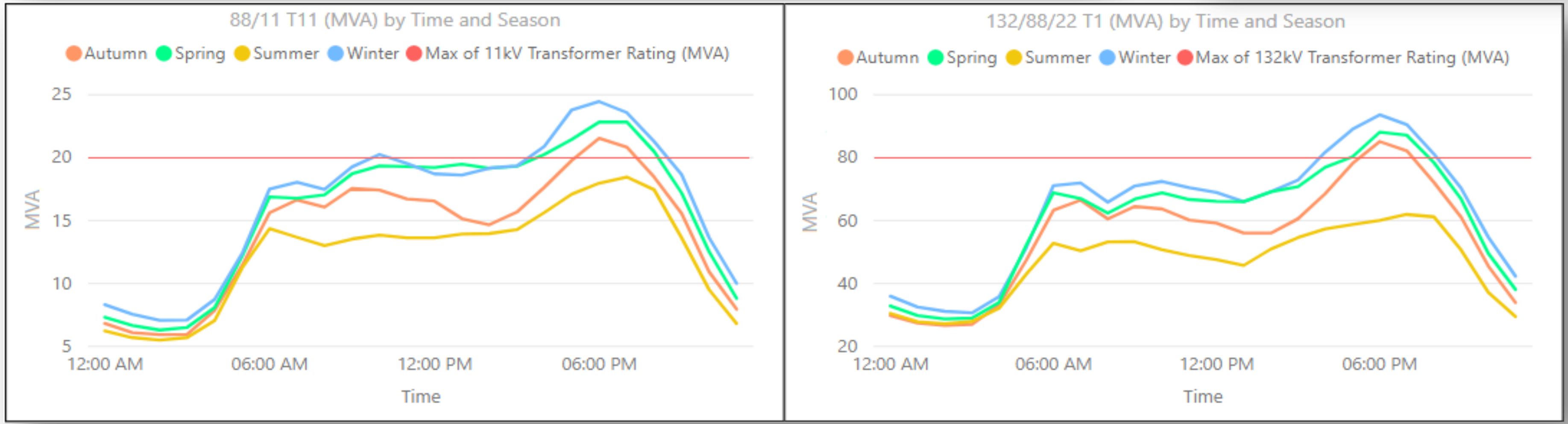
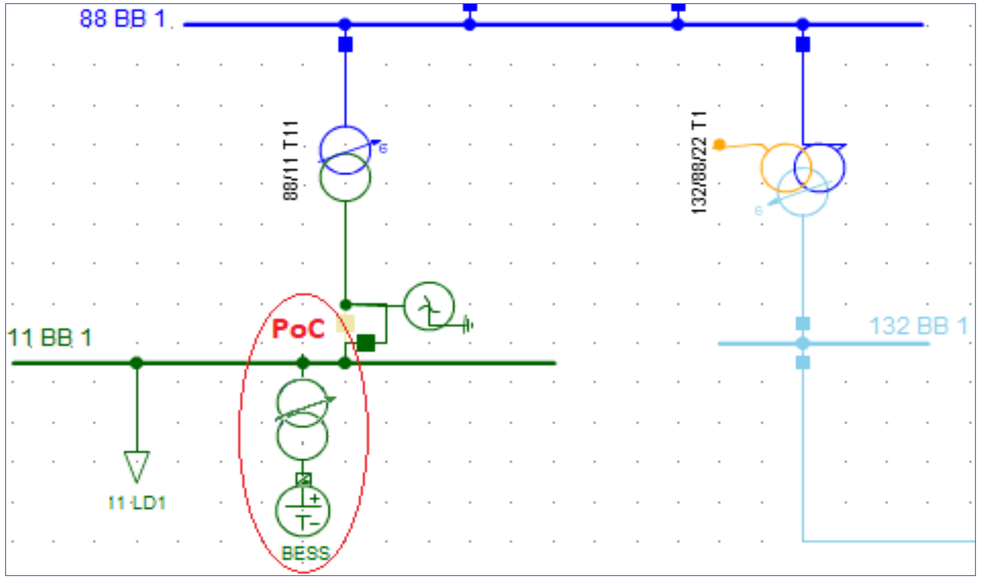


Preliminary Sizing & Static Load Flow Evaluation

- Iterative process to test the network operating limits:

Variable (units)	Comment
Rapid Voltage Change (%)	Voltage change resulting from the sudden BESS trip
Load Rejection (p.u)	Steady state voltage after BESS trip.
Thermal capacity (% nominal equipment rating)	Network thermal loading capacity observed when the storage is charging or discharging at full capacity.
Voltage Regulation (p.u voltage)	Network voltage levels during all operational states of the storage.
Fault Level (kA)	Substation breaker fault current ratings.

D)



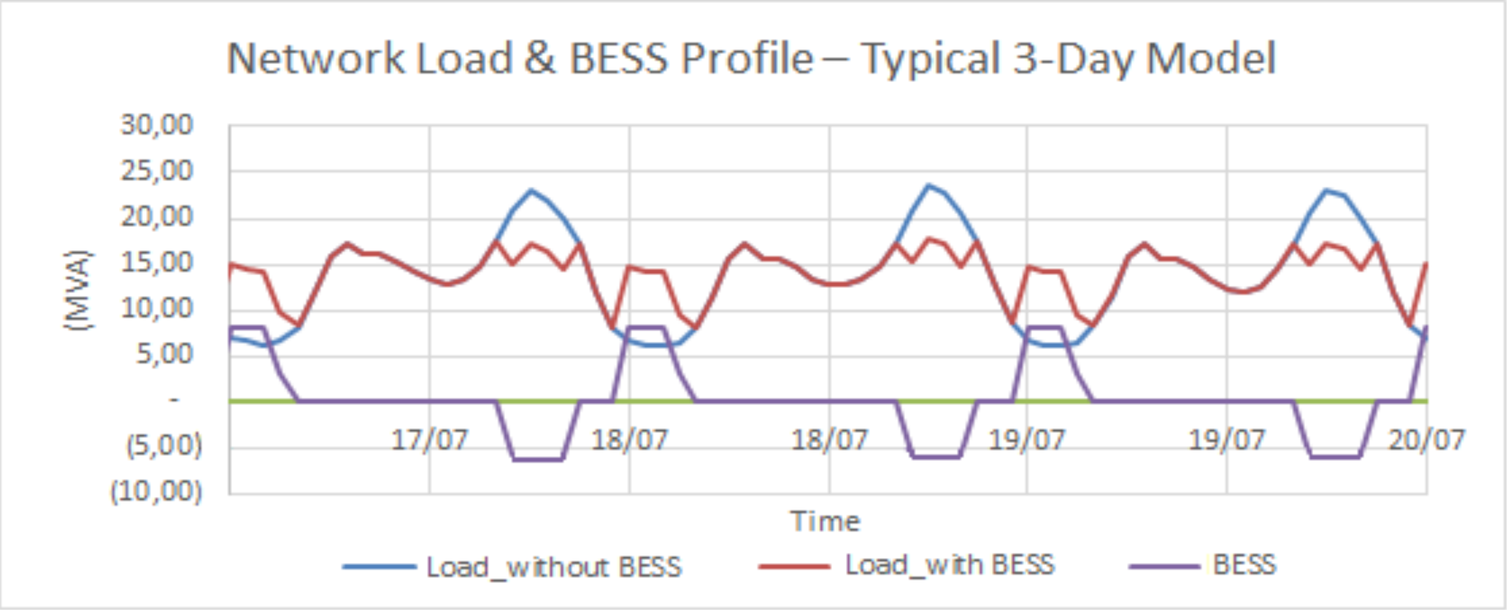
Storage Characteristic Modelling

- Model inputs:
  - Charge/ Discharge Periods.
  - Assumed BESS Characteristics

Excel

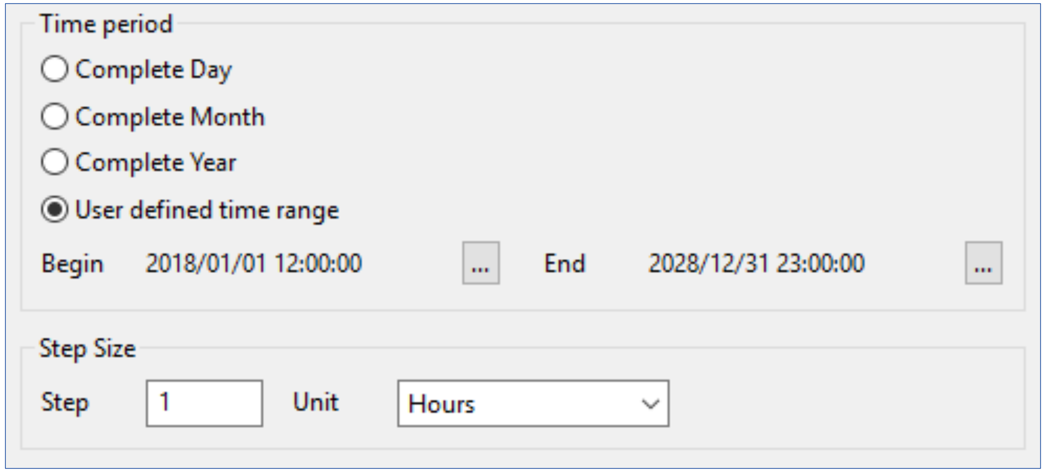
- Model output:
  - Life Expectancy.
  - Energy Losses
  - BESS Power Profile

E)



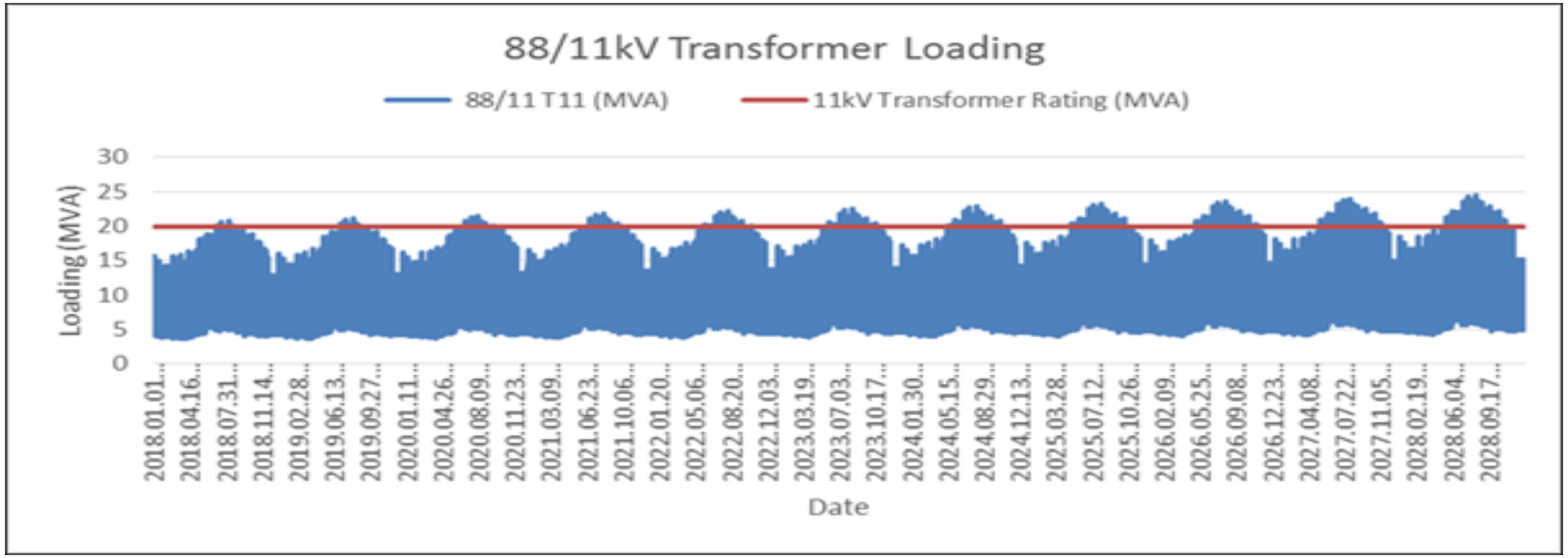
Power System Analysis

- Simulation inputs:
  - BESS profile (8760 data points)
  - All loads and generators populated with hourly loading data
  - 10-year load forecast populated for each load (keeping to a 1-hour resolution)
- Simulation outputs:
  - Transformer loading with BESS.
  - Network loading with BESS.
  - System voltage levels with BESS.

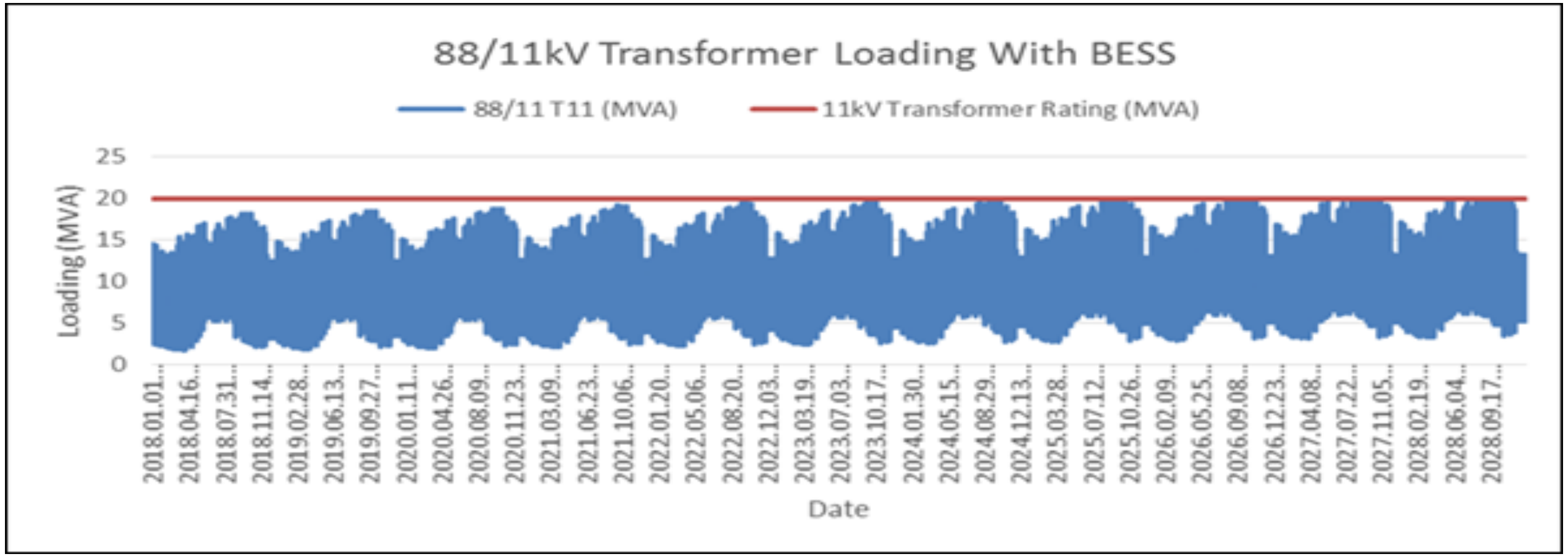


QDS Outputs – MV Transformer Loading

F)



G)



Concluding Remarks

- The 5-Step philosophy ensures an end-end technical planning analysis approach for BESS.
- Power system tools allow for temporal planning studies.
- Data requirements for temporal studies can be large, requiring high computing capabilities. Statistical techniques to reduce datasets do however exist.
- Data validation, including the modelling of BESS intrinsic characteristics is important.
- The capability of battery energy storage to stack benefits is what sets it apart from conventional strengthening solutions.
- Ultimately the economic evaluation of the BESS solution against conventional options will determine it's feasibility.

Acknowledgements

- BESS Working Group Chairman – Monde Soni
- BESS Modelling & Simulation Task Group Members.

Eskom

Thank You