Presentation outline

• Introduction to City Power
• Live-line network upgrade project
• Live-line tower replacement project
Two major precinct: Ellis Park and Soccer City
Opening and Closing matches were played in JHB
Total of 14 matches
Our business model

National Energy Regulator of South Africa (NERSA)

We are in the business of buying electricity and selling it to customers
A World Class Electricity Distributor
City Power Johannesburg transmission network

- **ESKOM 275kV**
  - Firm capacity 500 MVA
  - MD 419 MVA

- **ORELENTA 88kV Switchyard**

- **PROSPECT 4*250MVA**

- **FORDSBURG 4*250MVA**

- **ESKOM 275kV**
  - Firm capacity 750 MVA
  - MD 512 MVA

- **KELVIN PS 600MW**
  - MD 300 MVA

- **Eskom 275kV**
  - Firm capacity 500 MVA
  - MD 419 MVA

- **PROPOSED QUATTRO 275kV Intake from Eskom**

- **PROPOSED MONDEOR 88kV BUS**

- **88kV Transmission Circuits**

- Eldorado, Nancefield, Nirvana, Hurstfield, Industria, Eikenhof, and Soweto.

- Proposed Sebenza 275 kV Intake from Eskom

- Proposed Quattro 275kV Intake from Eskom

- Proposed Mondeor 88kV Bus

- Westfield

- MD 300 MVA

- Proposed Sebenza 275 kV Intake from Eskom

- Pritchard, Siemert, Central, Robertsham, Mondeor, Mulbarton, Moffat, Cleveland, Kazerne, Wemmer, and Van Beek

- Eldorado, Nancefield, Nirvana, Hurstfield, Industria, Eikenhof, and Soweto.

- Proposed Sebenza 275 kV Intake from Eskom

- Proposed Quattro 275kV Intake from Eskom

- Proposed Mondeor 88kV Bus

- Westfield

- Eldorado, Nancefield, Nirvana, Hurstfield, Industria, Eikenhof, and Soweto.

- Proposed Sebenza 275 kV Intake from Eskom

- Proposed Quattro 275kV Intake from Eskom

- Proposed Mondeor 88kV Bus

- Westfield

- Eldorado, Nancefield, Nirvana, Hurstfield, Industria, Eikenhof, and Soweto.
88kV Overhead line live-line network upgrade project
City Power’s 88kV overhead line transmission network approximately 65 years old

Load increases over years have led transmission lines and substations now exceeding firm capacities in certain areas

No space in existing servitudes for new transmission lines

Limited internal resources and maintenance records

Extended outages not possible due to load on certain transmission line and substations

Theft of tower cross members in certain areas
Possible alternatives to alleviated capacity constraints and increase capacity from 100MVA to 200MVA

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconduct with larger diameter conductors or increase the tension on existing conductors</td>
<td>Towers designed in the 1930s. Current condition considered not able to handle additional loading with existing span lengths</td>
</tr>
<tr>
<td>Rebuild lines and install new towers and larger diameter conductor or with double conductors</td>
<td>Towers to be changed and extended. Outages not possible</td>
</tr>
<tr>
<td>Increase the system voltage from 88kV to 132kV</td>
<td>Towers, power transformers and related switchgear to be changed</td>
</tr>
<tr>
<td>Install HV underground cables</td>
<td>Most expensive cost compared to any of the above alternatives</td>
</tr>
</tbody>
</table>
New conductor technology and specialized installation practices required to solve the network capacity constraints;

- New high temperature (180° C) Aluminum Conductor Composite Core (ACCC) conductors compared to more convention AAAC or ACSR conductors

- Live-line compared to dead-line reconductoring techniques considered

- Long rod silicon insulator compared to glass or porcelain insulated insulators

A unique solution was identified and evaluated that made commercial, technical, reliability of supply and performance sense
88kV Overhead line live-line network upgrade project

- Quanta Services who are market leaders in live-line (energized) work up to 765kV and also who had previous experience with live-line reconductoring projects where identified
- A strategic partnership was entered into with Quanta & EDISON SA to execute this “First-in-Africa” project
- CTC Lisbon ACCC conductor would be installed which would increase the rating of all circuits from 100MVA to 200MVA at 88kV - 180 °C operating temperature (emergency conditions)
- No towers had to be replaced only refurbished
- 132kV silicon long rod insulators installed to increase BIL and creepage – Johannesburg exposed to severe lightning storms and smog (smoke from fires in winter months) – Also vandal resistant
Safety was a major concern as no live-line work had been done by City Power – Auto reclose (ARC) protection had to be turned off at feeding stations while live-line work was in progress.

Skills transfer was a requirement – Quanta Services partner locally with EDISON JEHAMO POWER (EJP).

Special insulated robotic arms and bucket trucks imported by Quanta Services for the project.

Different live-line techniques employed on project;
- bare hand
- stick work
- robotic arms
88kV Overhead line live-line network upgrade project
88kV Overhead line live-line network upgrade project
88kV Overhead line live-line network upgrade project
Typical arrangement with by pass circuit and structures in place
**88kV Overhead line live-line network upgrade project**

**Typical arrangement with bypass circuit and structures in place**

<table>
<thead>
<tr>
<th>Cydna S/S Buz</th>
<th>1&lt;sup&gt;st&lt;/sup&gt; circuit conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; circuit conductor</td>
</tr>
<tr>
<td></td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; circuit conductor</td>
</tr>
<tr>
<td></td>
<td>5&lt;sup&gt;th&lt;/sup&gt; bypass conductor</td>
</tr>
<tr>
<td></td>
<td>4&lt;sup&gt;th&lt;/sup&gt; circuit conductor</td>
</tr>
<tr>
<td>Kelvin P/S Buz</td>
<td></td>
</tr>
</tbody>
</table>
### 88kV Overhead line live-line network upgrade project

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DISTANCE CIRCUIT LENGTH (km)</th>
<th>NO. OF CIRCUITS</th>
<th>YEAR COMPLETED</th>
<th>CONDUCTOR TYPE</th>
<th>TOTAL LENGTH OF ACCC INSTALLED LIVE-LINE (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kelvin to Cydna Circuit 1, 2, 3 &amp; 4</td>
<td>16.8</td>
<td>4</td>
<td>2010</td>
<td>Lisbon</td>
<td>201.6</td>
</tr>
<tr>
<td>Delta/Westfield/Kelvin Circuit 1</td>
<td>12</td>
<td>1</td>
<td>2010 (Emergency repair before SWC 2010)</td>
<td>Lisbon</td>
<td>36</td>
</tr>
<tr>
<td>Delta to Delbank Circuit 1 &amp; 2</td>
<td>1.26</td>
<td>2</td>
<td>2011</td>
<td>Lisbon</td>
<td>7.56</td>
</tr>
<tr>
<td>Orlando to Hursthill Circuit 1 &amp; 2</td>
<td>10.8</td>
<td>2</td>
<td>2011</td>
<td>Lisbon</td>
<td>64.8</td>
</tr>
<tr>
<td>Kelvin to Gresswold Circuit 1 &amp; 2</td>
<td>11.35</td>
<td>2</td>
<td>Installing (Completion early 2012)</td>
<td>Lisbon</td>
<td>68.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>378.06</td>
</tr>
</tbody>
</table>
88kV Overhead line live-line network upgrade project
88kV Overhead line live-line network upgrade project
Hardware components for ACCC

Typical dead end

Eyebolt

Wedge

Wedge Sleeve

Typical Joint (essentially 2 dead ends back-to-back)
• During the Soccer World Cup one of our 88kV lattice towers was badly damaged by a motor vehicle and had to be replaced as soon as an alternative tower could be sourced.

• The tower had to be replaced under live line conditions as it was not possible to move the load to different 88kV OHL circuits.

• Quanta Services had the resources to successfully complete this again “First-in-Africa” project for City Power.

• At a cost of R200mil the old damaged tower was removed and replaced with a new monopole tower with in 4 hours.
88kV Overhead line live-line network refurbishment project

a world class African city
88kV Overhead line live-line network refurbishment project
88kV Overhead line live-line network refurbishment project
88kV Overhead line live-line network refurbishment project
88kV Overhead line live-line network refurbishment project
Quanta Services and EJP also undertook two other live-line transmission line refurbishment project prior to the Soccer World Cup 2010 on our critical interconnectors where damaged insulator and fittings were replaced without interrupting any supply to customers.

The success of these upgrade and refurbishment projects was only possible because of the experience and ability of Quanta Services and EJP to execute these projects safely, within budget and on time under tight project schedules.

City Power will over the next few years replace transmission lines that have capacity issues with the services of Quanta Services – currently busy with the forth project.
THE END – THANK YOU