Energy Crises: Managed Opportunity

Presentation to
7th IHS Affordable Housing Conference
17 September 2015
Disclaimer

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Agenda

1. Is There an Energy Crises?
   - Eskom – Energy cost & availability
   - Load shedding
   - Blackout

2. Energy Transition
   - Energy transition – Drivers
   - Changing industry structure
   - Changing competitiveness of renewable technologies

3. Managed Opportunity
   - Risk to the business
   - Developing strategic responses
   - Structuring an energy response strategy
1. Is There an Energy Crisis?

- **Eskom** – Energy cost & availability
  - Load shedding
  - Blackout
Historical & Future Demand & Supply

- Demand Actual (Weekly avg)
- Demand 2% Forecast
- Demand IRP Update
- Demand 1% Forecast
- Total Actual capacity
- IRP 2010 revised Forecast capacity
- Actual Availability

EAF = 75% and Renewable capacity load factor = 30%

Immediate Crises

Supply

Demand

Actual
Forecast

Capacity
Eskom Total Capacity
Eskom Fleet – Reliability Trends

Unplanned maintenance downtime (UCLF) is increasing to an economically unsustainable level

Leading to

Energy sent out and energy availability (EAF) declining year-on-year with increasing negative consequences for the South African economy

Increasing Cost of Electricity

Increasing cost of energy

- Increasing cost of maintenance
- 27bn maintenance backlog for Distribution
- 270bn required for new capital infrastructure
- Increased primary energy cost
- Increased cost of environmental mitigation
- Cost reflective tariff
Long Term View
1. Is There an Energy Crisis?

- Eskom – Energy cost & availability
- Load shedding
- Blackout
Load Shedding 101

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.

Sources: 12 June 2015, M Roussouw, Making sense of South Africa’s energy constraints
Daily Load Profile
Eskom Challenge: Load Shedding Frequency & Duration – April 2015

Availability of OCGTs and STPPP reduced peak hour load shedding in April by more than 50%

Load shedding avoided during April 2015, due to OCGT and STPPP usage

- Shortfall is calculated on demand and 1000MW operational reserves
- Shortfall does NOT take primary energy constraints into account

- OCGTs and STPPP usage reduced load shedding by providing additional capacity
- If OCGTs and STPPP were not dispatched in April, load shedding would have been required everyday
- Actual load shedding was reduced by more than 50% owing to OCGTs and STPPP

Sources: Eskom Selective Reopener, Public Hearing Presentation on 23 June 2015
Load shedding – The cost to the RSA economy

- **Free Market Foundation**
  - Assume 3 hours of load shedding per day for 3 months. Average loss to the economy ranging from R50bn to R119bn (2008)
  - Drop in nominal GDP growth between 2.5% - 6% if 3 hours load shedding every 4th day over the period of a year
    (Source, 14 August 2012, Free Market Foundation, The cost of electricity shortfalls in RSA)

- **Standard Bank**
  - “Energy is oxygen to the economy. It is likely that structurally South Africa can’t grow at better than 2% — electricity is a significant factor,” said Standard Bank chief economist Goolam Ballim.
    (Source: 16 March 2014, Business Day Life, Eskom troubles will cap SA's growth at 2.5%)

- **Economist Estimation (Chris Yelland)**
  - Cost to the economy during stage 1 load shedding (800MW -1300MW) – 10 hours of blackouts per day for 20 days a month – is **R20bn per month**.
  - Cost to the economy during stage 2 load shedding (1600MW – 2100MW), using the same time parameters – is **R40bn per month**,
  - Cost to the economy during stage 3 load shedding (3200MW – 4400MW), using the same time parameters – is **R80bn per month**.
    (Source: Money web, 10 Feb. 2015, The costs of load shedding per stage)
1. Is There an Energy Crises?

- Eskom – Energy cost & availability
- Load shedding
- Blackout
Load Shedding & Blackout 101

1. If the engine capacity is too small for the truck's load, the engine slows.
2. To prevent the engine from stalling, load is shed in a planned manner.
3. Business suffers, but the truck moves and the engine is no closer to stalling.

If available generation can't meet system demand, system frequency drops < 50Hz
Eskom proactively implements controlled manual load shedding, 4 scheduled stages (1000-4000MW)
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.
2. If this all fails, the clutch automatically disengages, the engine runs, the truck stops.
3. If the engine stalls, we use the starter motor – for this the battery must be good.

A blackout is averted by the automatic protection scheme, multiple automatic layers.
If threat of blackout, some generators island, it takes only days to restore most electricity supplies.
A full black start is required, it takes 8hrs to start, 2 weeks to restore most electricity supplies.

Sources: 12 June 2015, M Roussouw, Making sense of South Africa's energy constraints
Blackouts: Protecting the Generation Frequency

Sources: Eskom Presentation on 17 March 2015
Other Major Blackouts - Summary

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Country</th>
<th>Cause</th>
<th>Duration</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2012</td>
<td>India</td>
<td>Large unscheduled flows</td>
<td>2 Days</td>
<td>700 million people affected (10% global population). Transport ground to a halt, miners were stuck underground without air conditioning, riots broke out, more than 1000 fires were reported, 1600 stores were looted and almost 4000 people were arrested. Crematoria stopped working, leaving bodies half burned.</td>
</tr>
<tr>
<td>2</td>
<td>2003</td>
<td>Italy</td>
<td>Storms caused power line trip</td>
<td>16 Hours</td>
<td>57 million people were plunged into darkness. But only three people died and there was very little looting. 30,000 people stranded on trains. All flights in Italy were also cancelled. Police described the scene as chaos but there were no serious accidents. The macroeconomic damage of this power outage in its entirety was calculated to be €1,1bn.</td>
</tr>
<tr>
<td>3</td>
<td>2011</td>
<td>USA California</td>
<td>Increased flows, trip of 500kV line</td>
<td>12 Hours</td>
<td>2.7 million people affected. Significant losses to restaurants and grocery stores…some sewage pumping stations to fail, resulting in contaminated beaches and potentially unsafe water supplies in several areas.</td>
</tr>
<tr>
<td>x</td>
<td>20xx</td>
<td>South-Africa</td>
<td>??</td>
<td>2 Weeks?</td>
<td>It would be very different in South Africa. Unlike India and Italy, we have no neighbours with enough power to kick-start our system back into operation. Water, sewerage and other infrastructure would stop working. Fuel pipeline deliveries would cease, causing all forms of travel to grind to a halt. Without rapid action by the army and police, pundits say anarchy would quickly ensue.</td>
</tr>
</tbody>
</table>

Source: 25 January 2015, Times Live, Eskom grid collapse warning 'misinterpreted'
Source: 2012, CIGRE, CIGRE, C2 – Large System Distribution Workshop
Blackouts – Probability of an occurrence is insignificant

The probability of a blackout is always a real but low probability event.

Many barriers exist to prevent this occurring, two of which will be described.  
• Manual load shedding  
• Automatic under frequency load shedding (UFLS)
Probability of a National Blackout - Speculations

Cape told to plan for total blackout

May 20 2015 at 10:00am
By Melanie Grilling

Cape Town - The Cape Town city council has been told to make contingency plans for a national blackout - although it says a total shutdown of the electricity grid is "highly unlikely".

Part of the contingency plan is to buy backup generators to keep essential services running.

Mayor Patricia de Lille announced in her budget speech on Friday morning that the city had budgeted R245 million to fund the contingency plan, the bulk of which will be spent on generators to keep essential services running.

De Lille said at a pre-budget briefing on Thursday that the city had been told in March by provincial disaster management to make preparations for a national blackout.

MEC Anton Bredell, confirmed on Thursday that the National Disaster Management Centre, with Eskom, had asked provinces to develop contingency plans for a "range of electricity-related emergencies" from a severe system constraints to a national blackout.

James-Brent Styan, spokesman for Local Government, Environmental Affairs and Development Planning, said on Thursday a blackout team had been convened with the provincial disaster management departments. Each department would develop its own plan, which would then be turned into an overarching plan.

Apart from generators, one of the crucial needs would be additional two-way radios as it would be essential to keep communication channels functioning during a blackout.

Hugo said sanitation "tops the list" of departments for which electricity is essential.

"We have over 300 sewage lift stations. Water is a close second... although it runs on pressure, there are areas that would lose water in higher-lying areas. Solid waste, the health department and disaster management, those are the key ones, and transport," Hugo said.

 Asked if the city was planning to stockpile diesel, given that a national electricity blackout was likely to see a

Summary Note – Energy Crises

1. Cost and Availability

2. Loadshedding

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

3. Blackout

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

- **Energy transition – Drivers**
  - Changing industry structure
  - Changing competitiveness of renewable technologies
Energy transition – the drivers

- **Security of Supply**
  - Eskom load shedding (frequency & duration)

- **Experience & Cost Curve of Green Energy Technologies**
  - Global trends
  - RSA trends

- **Environmental**
  - Greenhouse gas emissions savings reporting by corporations (local & global)

- **Legislation**
  - Carbon tax to be introduced in 2016

- **Economic**
  - Cost of business disruption

- **Regulatory**
  - Nersa policy on grid feedback

- **Political**
  - RSA commitment to the United Nation Climate Change Conference – Paris 2015
  - Government Department Initiatives

- **Other Disruptions**
  - Generation of primary energy for electric vehicles

- **Power Generation from Gas**
  - Pipeline gas
  - Liquefied Natural Gas (LNG)
2. Energy Transition

- Energy transition – Drivers
- **Changing industry structure**
- Changing competitiveness of renewable technologies
Changing industry structure to distributed supply

Experience from the German Power Generation Market

Source: 23 May 2013, Boston Consulting Group, The potential evolution of South Africa’s generation mix and the impact on Eskom
2. Energy Transition

- Energy transition – Drivers
- Changing industry structure
- Changing competitiveness of renewable technologies
Changing competitiveness of renewable technologies

Levelised cost of energy (LCOE), expectation for 2020 for South Africa
Including grid connection, excl. inflation, assuming a mature market, in $ct/kWh

By 2020, wind and PV will compete with coal on a ct/kWh-basis

Source: 23 May 2013, Boston Consulting Group, The potential evolution of South Africa’s generation mix and the impact on Eskom
LCOE of PV+battery systems compared to residential tariffs for Eskom customers
Incl. environmental levy, excl. VAT, ZAR ct/kWh

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption (kWh/month)</th>
<th>PV-only system(^2)</th>
<th>PV+battery(^2)</th>
<th>Homepower 1 block 1</th>
<th>Homepower 1 block 2</th>
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</thead>
<tbody>
<tr>
<td>2012/13</td>
<td>50</td>
<td>122.21 ct/kWh</td>
<td>~200 ct/kWh</td>
<td>82.08 ct/kWh</td>
<td>129.80 ct/kWh</td>
</tr>
<tr>
<td></td>
<td>350</td>
<td>111.42 ct/kWh</td>
<td>~215 ct/kWh</td>
<td>95.74 ct/kWh</td>
<td>131.17 ct/kWh</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>75.09 ct/kWh</td>
<td>~150 ct/kWh</td>
<td>60.83 Rcf/kWh</td>
<td>101.32 ct/kWh</td>
</tr>
</tbody>
</table>

PV cheaper than Homepower 1 block 2 tariff
PV+battery cheaper than Homepower 1 block 2 tariff

Risk of business model disruption (for both Eskom and Municipalities) from residential (and commercial) customers turning to partial autarky

Source: 23 May 2013, Boston Consulting Group, The potential evolution of South Africa's generation mix and the impact on Eskom
3. Managed Opportunity

• Risk to the business
• Developing strategic responses
• Structuring an energy response strategy
Managing the opportunity – Risks to the business

- Understand and quantify the energy related risks to your business
- Understand upstream and downstream value chain risks
- Understand risks to execution of mission critical processes
- Determine a strategic response
  - “Do nothing”
  - “Backup”
  - “Eskom plus me”
  - “Self”
  - “IPP”
- Select appropriate technology solution
3. Managed Opportunity

- Risk to the business
- Developing strategic responses
- Structuring an energy response strategy
Approach

Tier 1: Retrofit
(Eg. LED)

Tier 2: Heating & Cooling
(Eg. SWH & Heat Pump)

Tier 3: Energy Intensive
(Power Generation: PV, Bio, Wind etc.)

Business as Usual

“Do nothing”
“Back-up”
“Eskom + Me”
“Self”
“IPP”

Only now size Power Gen solution based on chosen strategic risk response
Developing strategic responses

Risk of

Required functionality of mission critical processes

Technology solution selection

Load Shedding - Scheduled
90%

Load Shedding - Unscheduled
50%

Blackout
10%

Strategic Response
- “Do nothing”
- “Backup”
- “Eskom + me”
- “Self”
- “IPP”
3. Managed Opportunity

- Risk to the business
- Developing strategic responses
- **Structuring an energy response strategy**
Structuring an energy response strategy

There are seven major components to ISO 50001:
1. General Requirements
2. Management Responsibility
3. Energy Policy
4. Energy Action Plan
5. Implementation and Operation
6. Performance Audits
7. Management Review

Implementation options
• In-source?
• Co-source
• Outsource
Government Initiatives – Taking the CSIR Off-Grid

- >1GW/y one ha Solar Plant under construction
- First 4 buildings equipped with PV Rooftop modules
Private Industry – Taking the MTN Campus Off-Grid

- 10MW Power (48%)
- Cooling
- Heating
- Overall: 90% Efficiency

Source: Dec 2010, African Energy Journal
Summary
Summary

1. Is there an energy crises?

Increasing cost of energy

2. Energy transition

Base load cost

Replaced by

Emerging energy technologies

3. Managed opportunity

There are seven major components to ISO 50001:
1. General Requirements
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3. Energy Policy
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