

## Global Challenges at the Intersection of Trade, Energy and the Environment

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# Challenges at the Intersection of Trade, Energy and the Environment for the African Continent<sup>1</sup>

Pat Naidoo<sup>2</sup>

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<sup>1</sup> Background presentation prepared for **Panel 4: Environmental Issues in the Trade and Energy Context**, of the Conference *Global Challenges at the Intersection of Trade, Energy and the Environment* 22nd and 23rd October 2009, Organised by the Centre for Trade and Economic Integration (CTEI) at the Graduate Institute of International and Development Studies, Geneva, in collaboration with the World Trade Organization.

<sup>2</sup> Pat Naidoo, Senior General Manager of Transmission, ESKOM, South Africa

The 16<sup>TH</sup> International Symposium on High Voltage Engineering



## OPENING ADDRESS

### THE CHALLENGES AND OPPORTUNITIES FOR ELECTRICITY SUPPLY IN SOUTHERN AFRICA

by

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and

**Dr Pat Naidoo**

Chief Executive : Western Power Corridor Company

24<sup>TH</sup> AUGUST 2009  
CAPE TOWN – SOUTH AFRICA



# Welcome



## South Africa's National Electricity Utility

**Eskom**

Classic and Traditional

Vertically Integrated Electricity Company  
(Generation, Transmission and Distribution)

Serving National and Regional Customers

Monopoly Market Environment

Regulated National Tariffs, Quality of Supply and  
Quality of Service

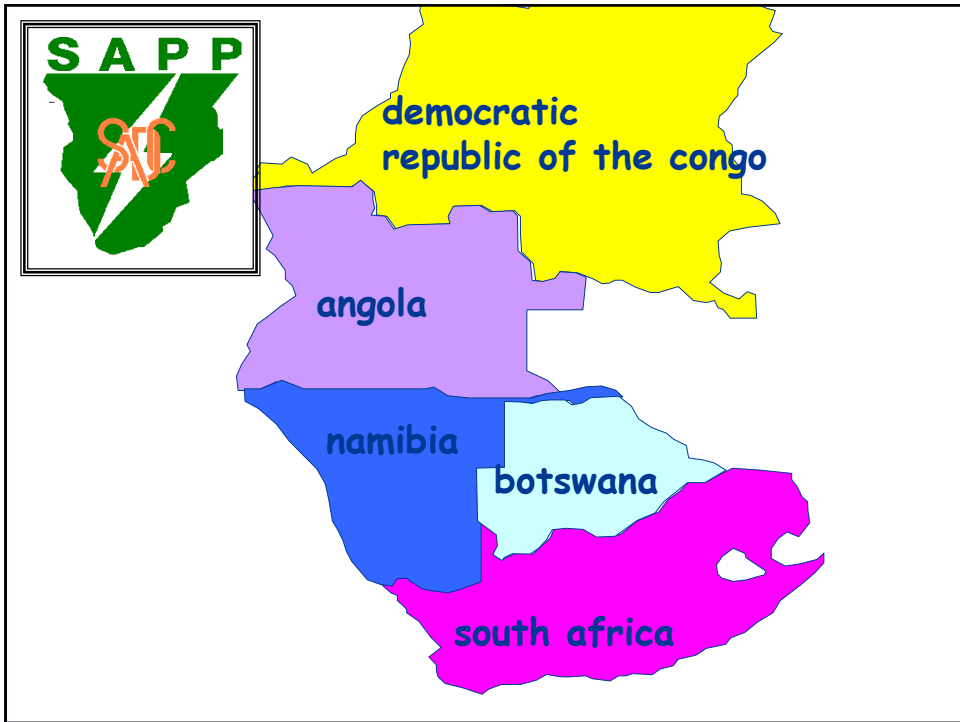


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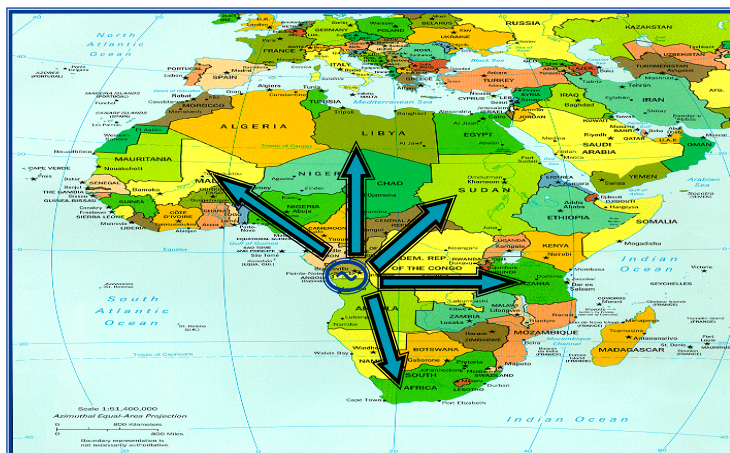


The Western Power Corridor Company (PTY) LTD





## The Congo River A Renewable Energy Resource of Africa Contributing to Continental Economic Renaissance.



## **South Africa**

**44 GW Installed Capacity**

**Next 20 years – add 40 GW**



## **World's Lowest Cost**

**Dr McRae and his team delivered sterling leadership to the electricity supply industry by promoting large scale development of power generation and transmission facilities for customer energy requirements at the world's lowest cost.**

**This leadership has delivered the prosperous South Africa that we all enjoy.**



**This leadership must continue**

**South Africa, Southern Africa,  
Continental Africa needs this  
leadership....resource rich but  
loaded with poverty.**

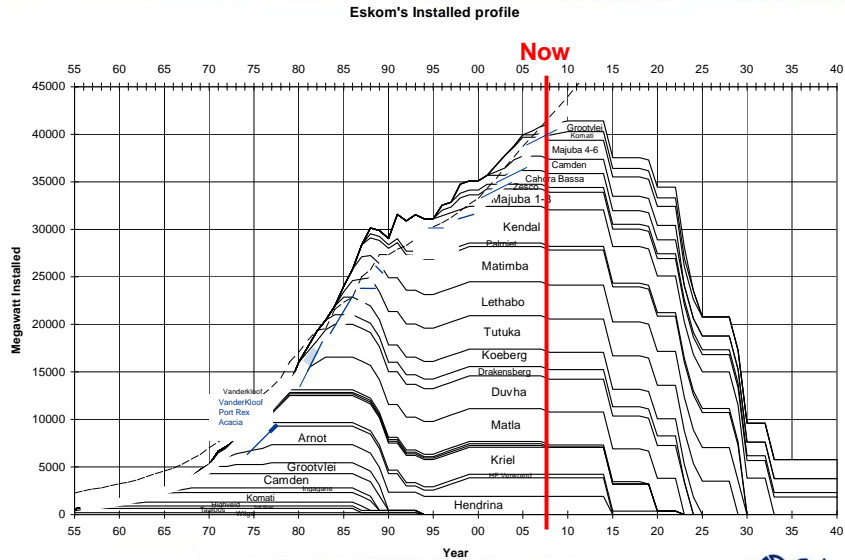


**Dream ...Dr Ian McRae...Continues...**

**Southern Africa become the  
world's energy intensive  
valley; made possible by the  
regions renewable energy  
resources, at the world's  
lowest cost**



## RESULTS : 6 x 600 MW Thermal + Nuclear + Peaking 400 kV Grid + 765 kV HVAC; 533kV HVDC



## RESULTS

..... Industrialised South Africa

..... South Africa became the world's benchmark for worlds lowest cost electricity...continues to be the benchmark

..... Delivered the Miracle Change Over in SA

2010 : FIFA WORLD CUP



## Present Day : Key Challenges

- ❑ South Africa has reached the end of its surplus generation capacity
- ❑ **Climate Change and Global Warming indicate that we have the wrong primary energy source; thermal coal and carbon emissions**
- ❑ The uplift on price/cost of electrical energy would displace our global competitiveness
- ❑ Still a developing country with access and affordability of electrical energy being key expectations

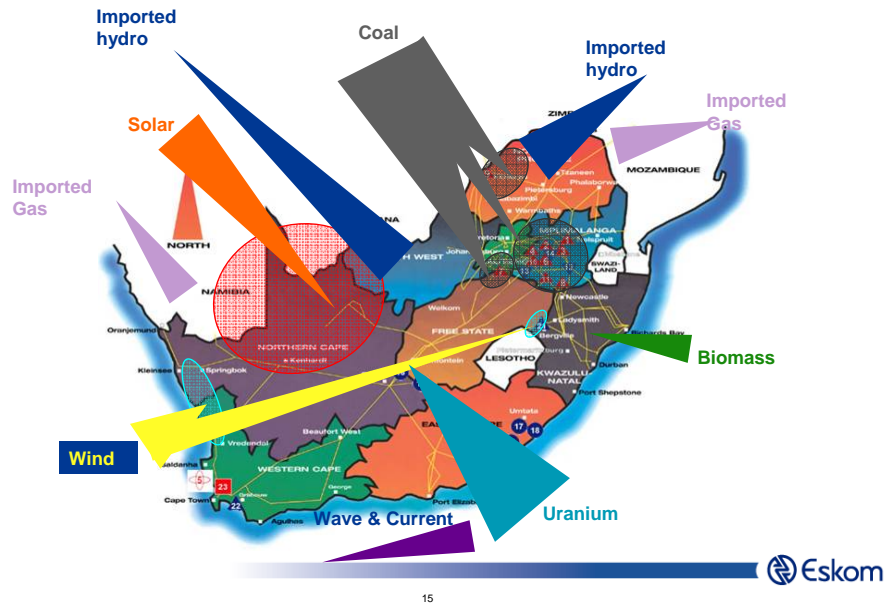
## ESKOM 6 POINT PLAN ON CLIMATE CHANGE

### 6 key areas have been defined

- **Diversification** of the generation mix to lower carbon emitting technologies
- **Energy efficiency** measures to reduce demand and greenhouse gas and other emissions
- **Adaptation** to the negative impacts of climate change
- **Innovation** through research, demonstration and development
- **Investment** through carbon market mechanisms
- **Progress** through advocacy, partnerships and collaboration



## Energy Diversification: Opportunities



## RENEWABLES IN SA

**Still in its Infancy in South and Southern Africa**

**Certainly an energy source for commercial application**

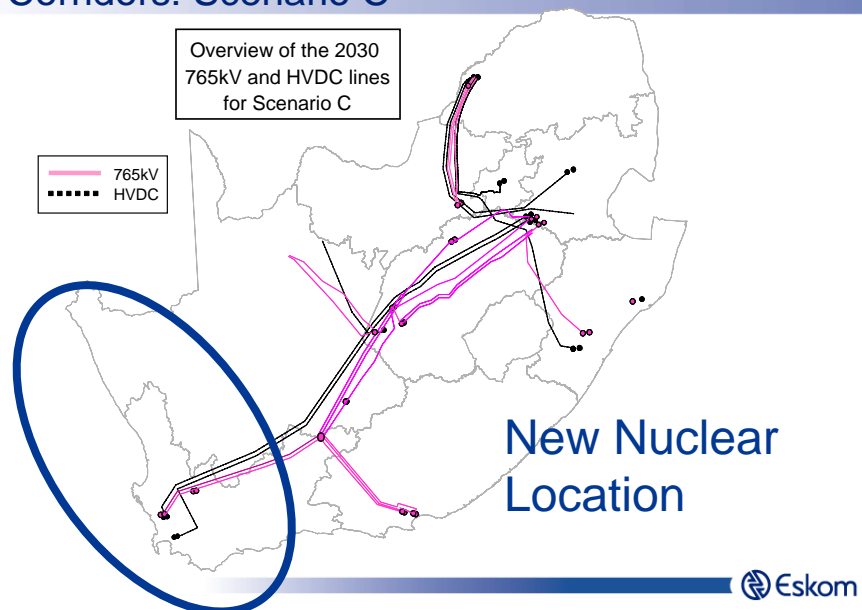
**Barrier to entry has been the low cost of electricity**

## Large Scale Bulk Power - New Nuclear

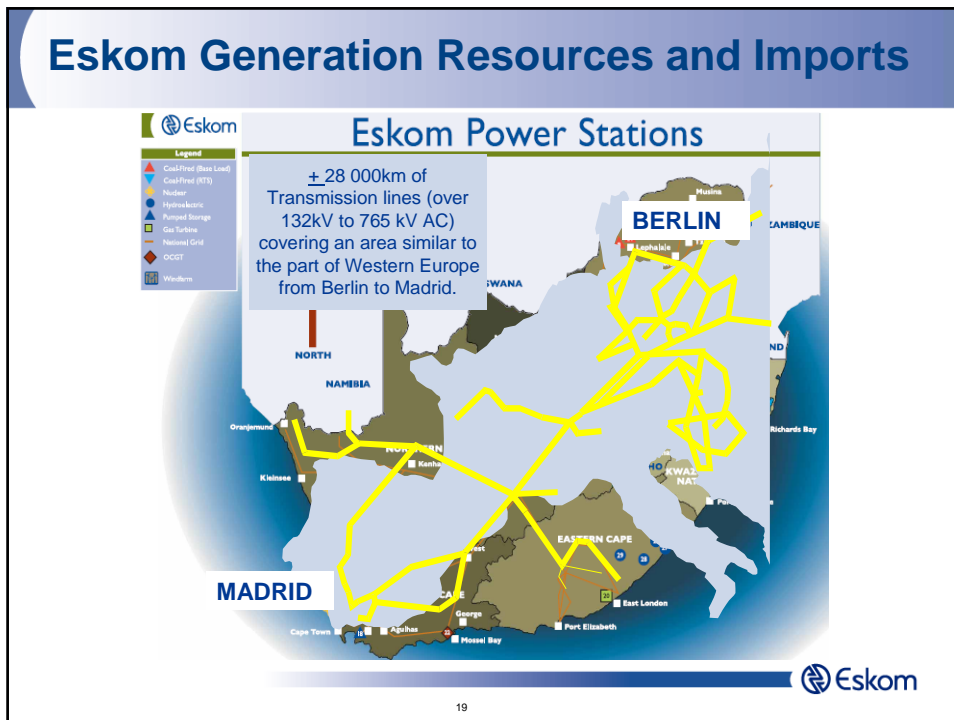
- + 20 GW New Nuclear for New Demand
- + 20 GW to displace Aged Thermals
- All generation again at one site,  
Western/Southern Cape ...COLD Atlantic for  
Cooling



## 2030 Grid Expansion Plan – Overview of Power Corridors: Scenario C



## Eskom Generation Resources and Imports



## Introduce Africa's Large Scale Hydros

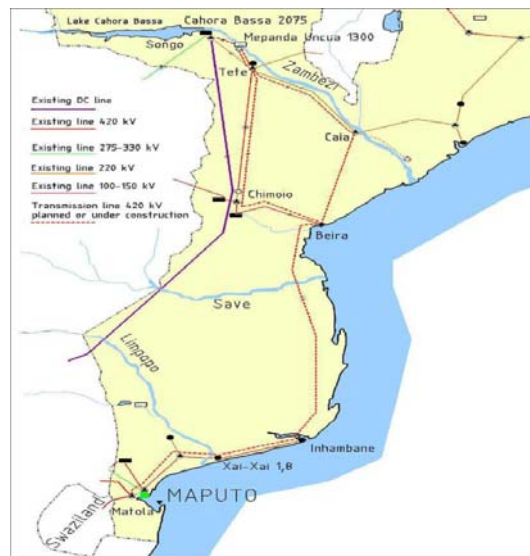
## Africa's Hydro Power Locality 100 GW

**PRIORITY AREAS FOR INCREASED  
HYDROPOWER POTENTIAL  
based on NEPAD I-STAP**



Eskom

## Zambesi and Lake Cahora Bassa 25 GW

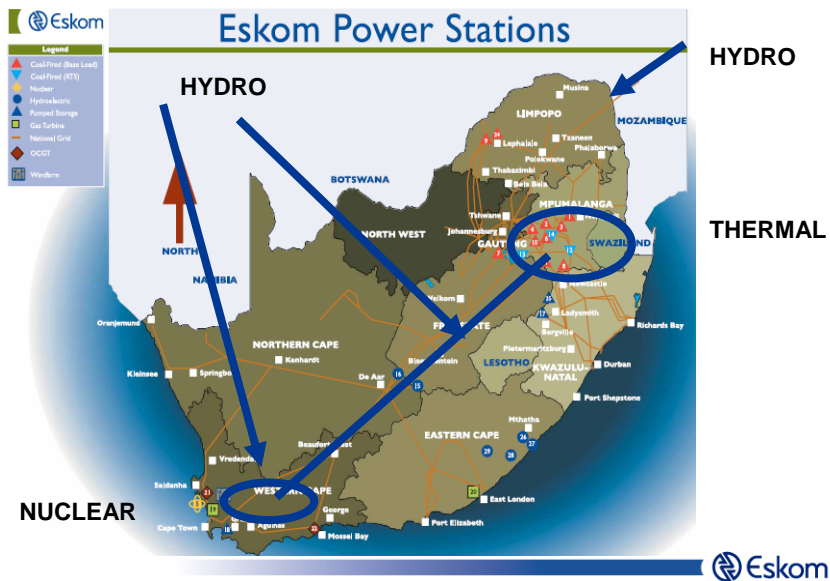


Eskom

# INGA on the Congo River 50 GW



## Imported Hydro : Strategic – Longer Term Development



## Strategic Imported Hydros

- **Renewable, Natural and Sustainable Energy Source**

**Bulk Power at Much Lower costs**

**Westcor**

**Congo River Inga Site Development**

**Inga 3 - 5000 MW**

**Energy Delivered : 5 US cents/kWh**



## SECRET

**PRIMARY ENERGY**

**NATURAL and RENEWABLE**

**Jan to Dec 5000 MW = USD 2,2 billion**

**Repeats following Jan to Dec**

**Another USD 2,2 billion**

**Repeats for another year, for ever**



## AC System Challenge

With Increasing Loading

With longer transmission distances

The AC System transfer is limited to the surge impedance load

$$SIL = U^2/Z_c$$

For Higher SIL : Increase U or Decrease  $Z_c$  by employing FACTS technology or

Introduce HVDC



## Towards HVDC

Drop Frequency

Lose the line charging current

Lose the line inductive voltage drops

Work with just the series resistance



## **UHVDC – 1200 kV**

**Power Losses still substantially high over  
the very long distance**

**Do we move to a higher DC voltage ?**

**What about other factors ?**

**Corona and Field Effects**

**Lightning Performance with the Higher BIL**



## **Key Focus Areas Going Forward**

### **HIGH VOLTAGE ENGINEERING**

**hv measurements**

**electromagnetic fields**

**hv insulation**

**diagnostics**

**outdoor insulation**

**system aspects**

**transients**



## Research and Investigations

### 1. Prepare the 765 kV HVAC Transmission Line for 800 kV HVDC Application

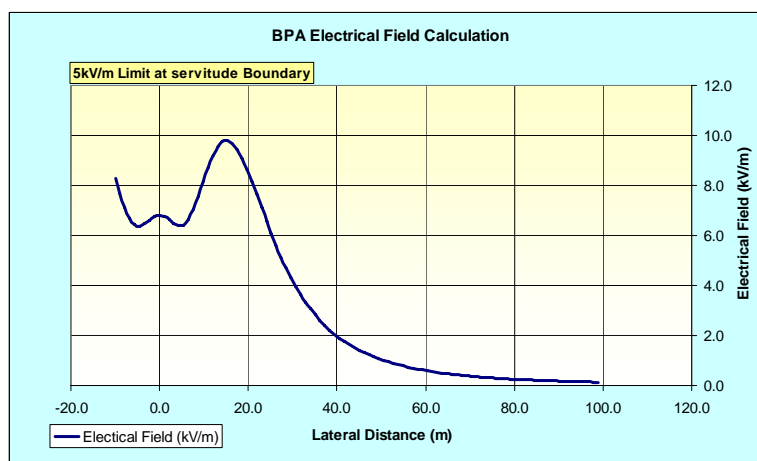
For Power Imports from Hydro Resources located in Southern Africa

For Power Exports from the Nuclear Resources located in the Cape of SA

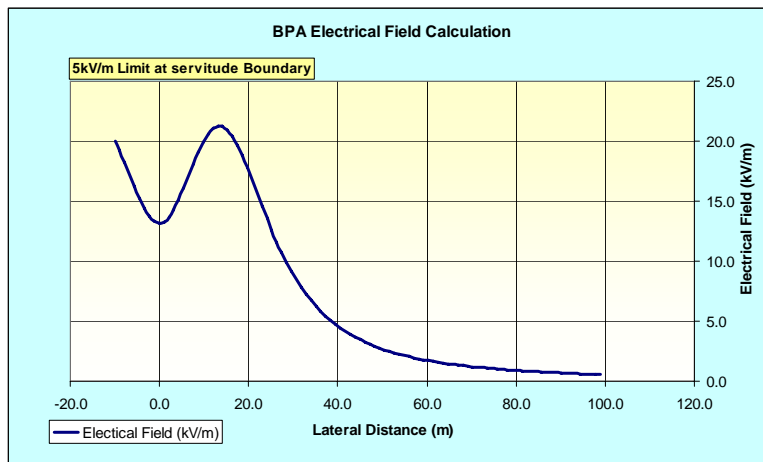


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## 765 kV : Operating at 765 kV HVAC



## 800 kV : Operating at 800 kV HVDC



Powergrid of India HVDC Limit 20 kV/m - 5000 km



## Research and Investigations

Prepare the 765 kV HVAC Transmission Line for 800 kV HVDC Application whereby the two outer conductors are the DC bipoles and the centre phase serves as metallic earth return for monopole operation.

- |        |  |
|--------|--|
| 100%   | Excellent Mechanical and Electrical Performance and the best design for very long distance application |
| Zero 0 | Electrical and Mechanical Faults ( 1 fault in 1-2 years)   |

Bulk Power Transfer : 2500 MW on HVAC ; 6000 MW on HVDC with 3000 MW on Monopole Capability.



## 765 kV HVAC Excellence in Performance

- Eskom and Academia and Industry did excellent laboratory work in the preparation of the 765 kV Designs
- Megawatt Park Corona Cage, SABS/CSIR Lightning Laboratory and Koeberg/Sasolberg Insulator Test Facilities are testimony of work well done



## Research and Investigations

2. Investigate the development of 1200 kV HVDC to cater for the increasing distances between source and load across continental Africa; distances move from 3000 km to 6000 km
3. Continue to investigate the application of 1000 kV HVAC technology as promoted by State Grid of China



## Research and Investigations

4. **New Generation Nuclear Machines will be of 1200 to 1500 MW Capacity; power system modelling and analysis will be at the forefront to tackle issues such as SSR, Application of FACTS and HVDC Transmission Integration**
5. **For the above, explore RTDS Application as we start to commission and bring on the new generation power stations.**



## Conclusion

- **National Utilities will work on the delivery of affordable electrical energy to customer satisfaction**
- **Academia and Industry must support the long term plans with new and innovative designs and trained engineers**

**Collectively, we work together ...we are dealing with voltages at the upper end....working in multiple environments, we will need all our knowledge in HIGH VOLTAGE ENGINEERING to deliver an affordable and quality supply to customers**



**Thank You**  
**Enjoy the Proceedings**

