SOUTHERN AFRICAN POWER POOL

www.sapp.co.zw

Update on RE Power in the SAPP

Dr. Lawrence Musaba

SAPP CC Manager

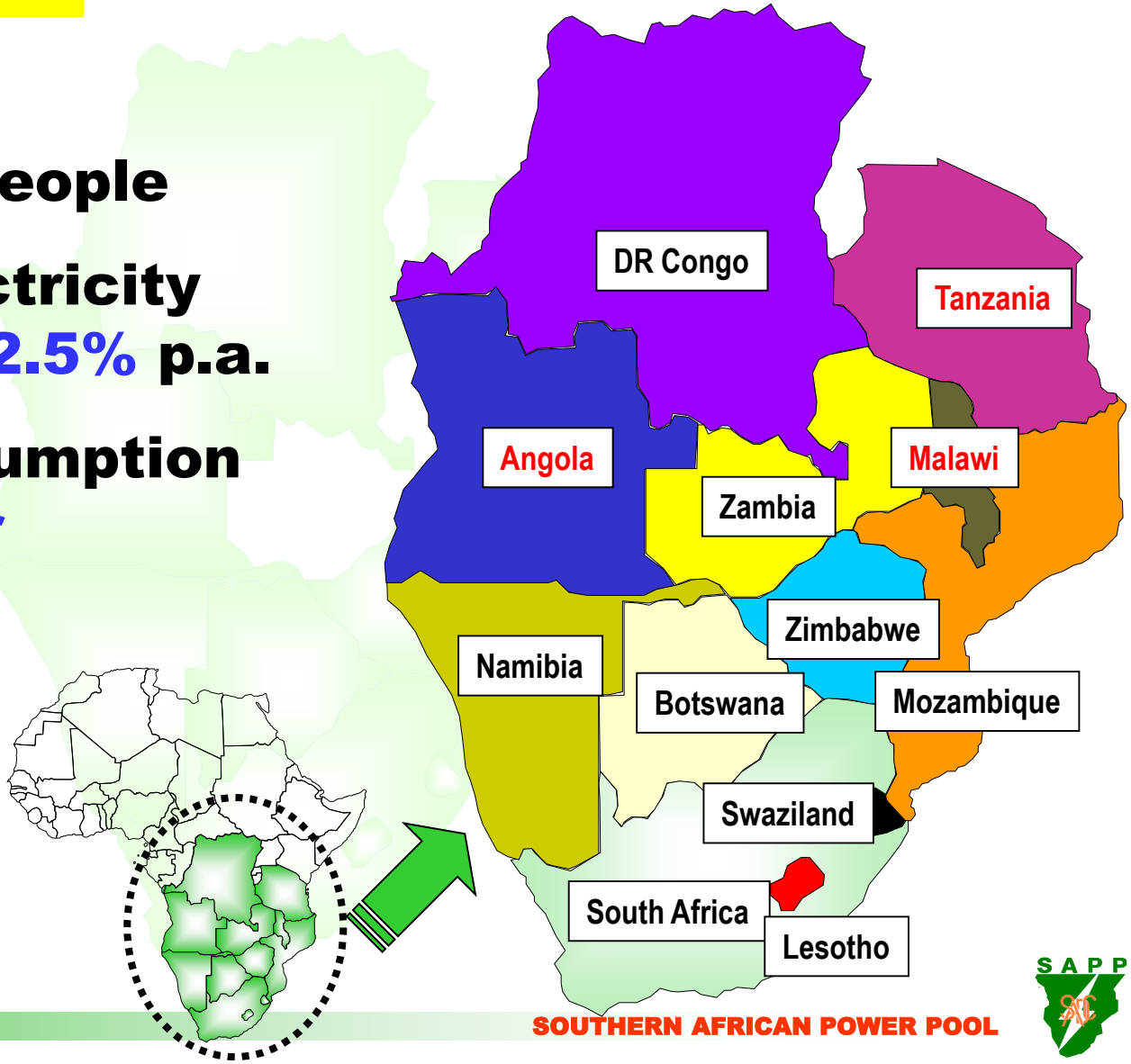
IRENA Initiative for an Africa Clean Energy Corridor
Executive Strategy Workshop
IRENA Headquarters
Abu Dhabi, United Arab Emirates
22-23 June 2013

CONTENTS

1. OVERVIEW OF THE SAPP

1.1 Geographic

- 12 Countries
- 250 Million people
- Average Electricity growth rate 2.5% p.a.
- Energy consumption 400TWh/year

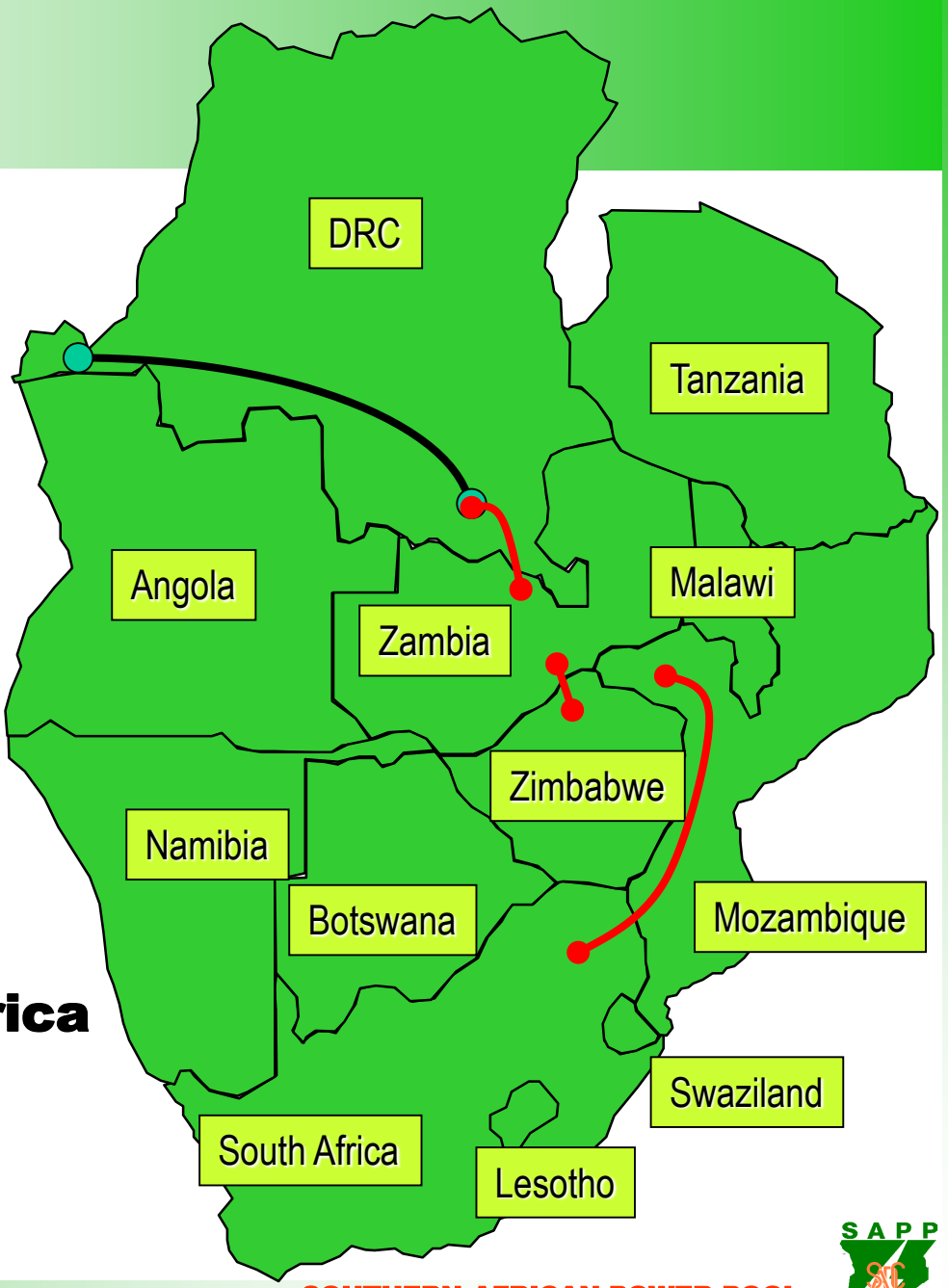


1.2 Historic (1)

1950s: DRC-Zambia
500kV HVDC 1700km
1x220kV AC, 210MW

1960s: Zambia – Zimbabwe
2x330kV AC, 1400MW

1975: Mozambique – South Africa
533kV HVDC – 1400km
2000MW



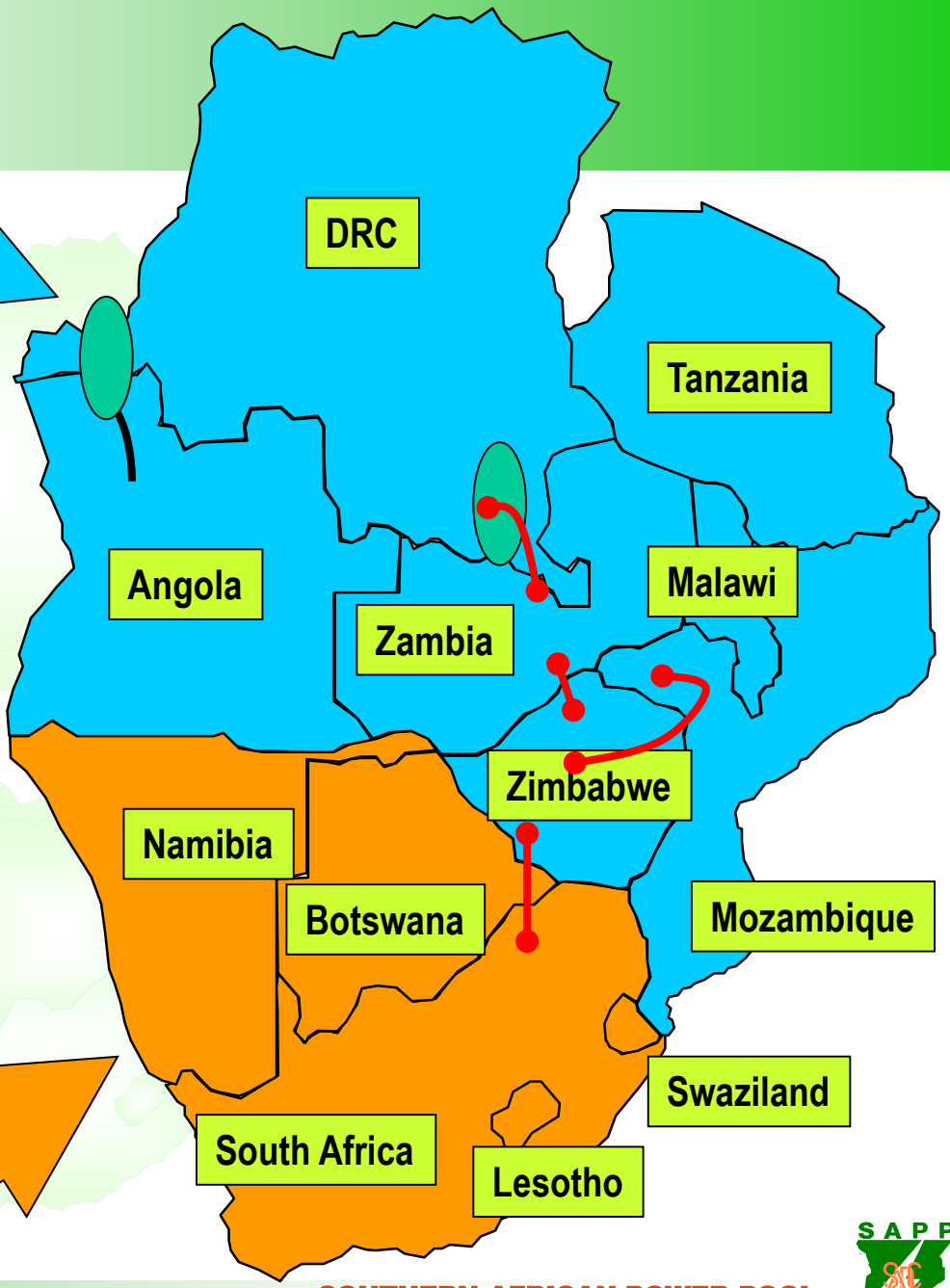
1.2 Historic (2)

Hydro Northern Network

Two networks linked by weak lines at 220kV & 132kV via Botswana

In 1995 the 400kV was constructed from Zimbabwe to South Africa via Botswana.

Thermal Southern Network



1.2 Historic (3)

- The interconnection of the northern and southern networks created a platform for regional trade and cooperation.

- In 1995, the Ministers responsible for energy in the Southern African Development Community (SADC) signed Inter-Government MOU that lead to the creation of a power pool under the name, Southern African Power Pool (SAPP).

- The Aim was to optimise the use of available energy resources in the region and support one another during emergencies.

1.4 Governing Legal Documents

- **Inter-Governmental MOU**
  - Established SAPP.
  - Signed by SADC Member Countries in 1995.
  - Revised document signed on 23 February 2006.
- **Inter-Utility MOU**
  - Established the Management of SAPP.
  - Revised document signed on 25 April 2007.
- **Agreement Between Operating Members**
  - Signed by Operating Members only.
  - Review document signed in April 2008.
- **Operating Guidelines**
  - Under Review and will be finalized in 2013.

1.5 Membership

No	Full Name of Utility	Status	Abbreviation	Country
1	Botswana Power Corporation	OP	BPC	Botswana
2	Electricidade de Mocambique	OP	EDM	Mozambique
3	Hidro Electrica Cahora Bassa	OB	HCB	Mozambique
4	Mozambique Transmission Company	OB	MOTRACO	Mozambique
5	Electricity Supply Corporation of Malawi	NP	ESCOM	Malawi
6	Empresa Nacional de Electricidade	NP	ENE	Angola
7	ESKOM	OP	Eskom	South Africa
8	Lesotho Electricity Corporation	OP	LEC	Lesotho
9	NAMPOWER	OP	Nam Power	Namibia
10	Societe Nationale d'Electricite	OP	SNEL	DRC
11	Swaziland Electricity Board	OP	SEB	Swaziland
12	Tanzania Electricity Supply Company Ltd	NP	TANESCO	Tanzania
13	ZESCO Limited	OP	ZESCO	Zambia
14	Copperbelt Energy Corporation	ITC	CEC	Zambia
15	Lunsemfwa Hydro Power Company	IPP	LHPC	Zambia
16	Zimbabwe Electricity Supply Authority	OP	ZESA	Zimbabwe

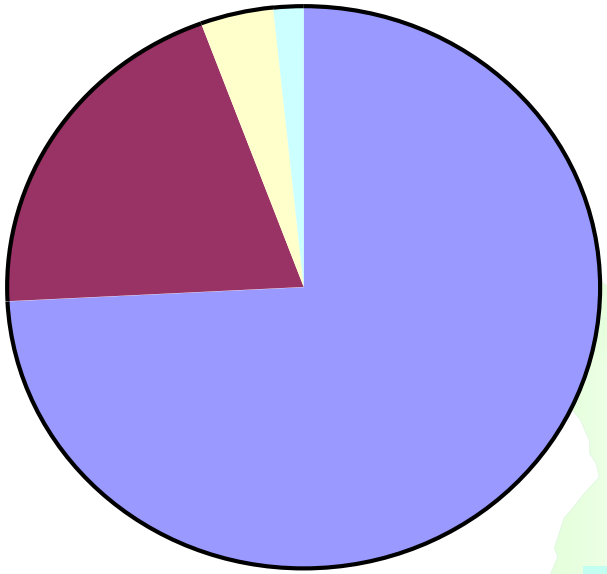
OP = Operating Member
NP = Non-Operating Member
OB = Observer
IPP = Independent Power Producer
ITC = Independent Transmission Company

CEC & LHPC (Zambia) are new Members of SAPP

1.6 SUPPLY AND DEMAND

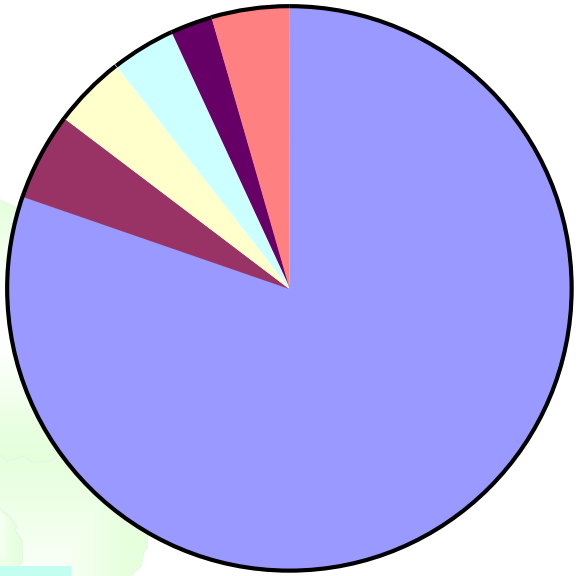
No.	Country	Utility	Installed Capacity [MW] As at Jan 2013	Available Capacity [MW] Jan 2013	Suppressed Demand & Forecast Demand	Capacity Shortfall including reserves, MW	Calculated Reserve Margin, %
1	Angola	ENE	1,793	1,480	1341		
2	Botswana	BPC	352	322	604		
3	DRC	SNEL	2,442	1,170	1398		
4	Lesotho	LEC	72	72	138		
5	Malawi	ESCOM	287	287	412		
6	Mozambique	EDM /HCB	2308	2,279	636		
7	Namibia	NamPower	393	360	635		
8	South Africa	Eskom	44,170	41,074	42416		
9	Swaziland	SEC	70	70	255		
10	Tanzania	TANESCO	1380	1,143	1444		
11	Zambia	ZESCO / CEC/LHPC	1,870	1,845	2287		
#REF!	Zimbabwe	ZESA	2,045	1,600	2267		
TOTAL SAPP			57,182	51,702	53,833	(7,709)	-4.1%
Total Interconnected SAPP			53,722	48,792	50,636	(7,079)	-3.8%

1.7 Generation Mix Year 2012



- 74.3% Coal
- 20.1% Hydro
- 4.0% Nuclear
- 1.6% Gas/Diesel

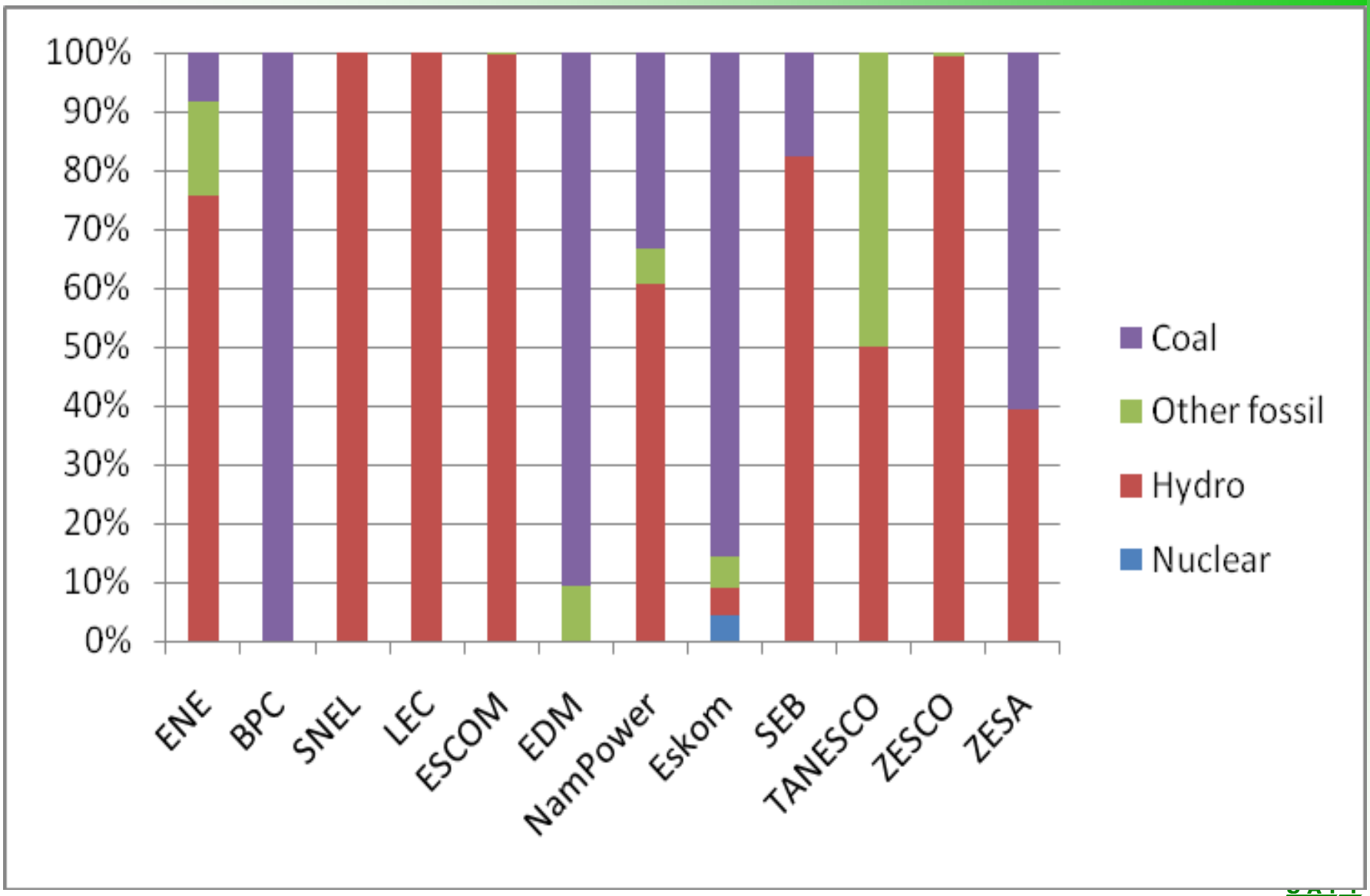
1.8 Country Contribution Year 2012



- 80.4% South Africa
- 5.0% Mozambique
- 4.1% Zimbabwe
- 3.6% Zambia
- 2.6% DRC
- 4.4% Rest

1. **Supply mostly from coal.**
2. **Largest market is South Africa.**

1.9 Current Utility Generation Mix Contribution



1.10 Existing Hydropower Generation in the SAPP

NO	COUNTRY	UTILITY	CAPACITY MW	PER CENT %
1	Botswana	BPC	NIL	NIL
2	Mozambique	EDM	498	91
3	Angola	ENE	760	64
4	Malawi	ESCOM	286	100
5	South Africa	Eskom	2,000	5
6	Lesotho	LEC	72	100
7	Namibia	NamPower	240	61
8	Swaziland	SEC	63	88
9	DRC	SNEL	2,442	100
10	Tanzania	TANESCO	561	50
11	Zimbabwe	ZESA	750	37
12	Zambia	ZESCO	1,802	99
13	Mozambique	HCB	2,075	
14	Zambia	LHPC	40	
	TOTAL		11,589	

- ✓ The current hydropower contribution is only **20%** of the SAPP generation mix.

2. OVERVIEW OF SAPP MASTER PLAN

2.1 OBJECTIVES

The Pool Plan Study Objectives were:

- ✓ **Develop an integrated generation and transmission expansion plan for SAPP.**
- ✓ **Determine the benefits that can be derived for the members from coordination of their individual expansion plans.**

2.2 DEVELOPMENTAL PROCESS

The process for developing the SAPP Pool Plan of 2009 included:-

- **Adoption of the planning assumptions**
- **Determination of the electricity load forecasts**
- **Modelling scenarios based on planning assumptions**
- **Determination of the base plan derived from a least cost generation investment**
- **Risk adjustment of the base plan, based on:**
  - **i. Most probable scenarios**
  - **ii. National Government policy & objectives**
- **Approval of the SAPP Pool Plan**

2.3 BASE CASES

Two cases were considered:

- ✓ A **Base Case** based on the existing generation & transmission plans for each of the 12 SAPP utilities.
- ✓ An **Alternative Case** that considers various scenarios for the optimization of generation and transmission capacity additions assuming free trade, no constraints (both internal and external).

Three Alternative Cases were considered:

- ✓ **Initial Alternative Case** was based on the now revised demand forecast. Initially the load forecast was set at **2.4%.** In the revised one, **4.3%** is used.
- ✓ **Updated Alternative Case** that treats nuclear units with operating dates 2017-2025 as **committed**.
- ✓ **Revised Alternative Case** that treats nuclear units as **not committed**.

The **Revised Alternative Case** was adopted for the SAPP Pool plan.

2.4 POOL PLAN RESULTS

- Capacity deficit from 2008 to 2013
- Base Case 4,870 MW more capacity and USD 8.7 billion more expensive (2009 to 2025)
- High cost coal displaced by low cost hydro
- Alternative case adds 8,400 MW less thermal and 5,600 MW more hydro than Base Case
- Total additional capacity of 57,000 MW at a cost of USD 83 billion
- When nuclear is not committed financial requirements reduce by USD 48 billion.
- At CO2 cost of USD30 /tonne nuclear, hydro, combined cycle replace coal units.

2.4 POOL PLAN RESULTS

- Confirms significance of coordinated investments
- Regional Least Cost Plan dominated by hydro, nuclear power based plants & gas based plants
- Most new coal fired generation were not accepted in the least cost plan
- Interconnecting Non Operating Members should be accelerated.
- Recommends a central transmission corridor from DRC to South Africa via Zambia and Zimbabwe

3. GENERATION PROJECTS

The Alternative case shows that 56,687 MW of new additional power generation capacity would be required by 2025 as follows:

- ✓ **Coal fuel plants provide most new capacity** — **23,883 MW**
- ✓ **Hydro and pumped storage are next** — **18,045 MW**
- ✓ **Diesel fueled peaking units** — **12,594 MW**
- ✓ **Gas fueled combined cycle plants** — **2,164 MW**

The optimized plan includes no new nuclear.

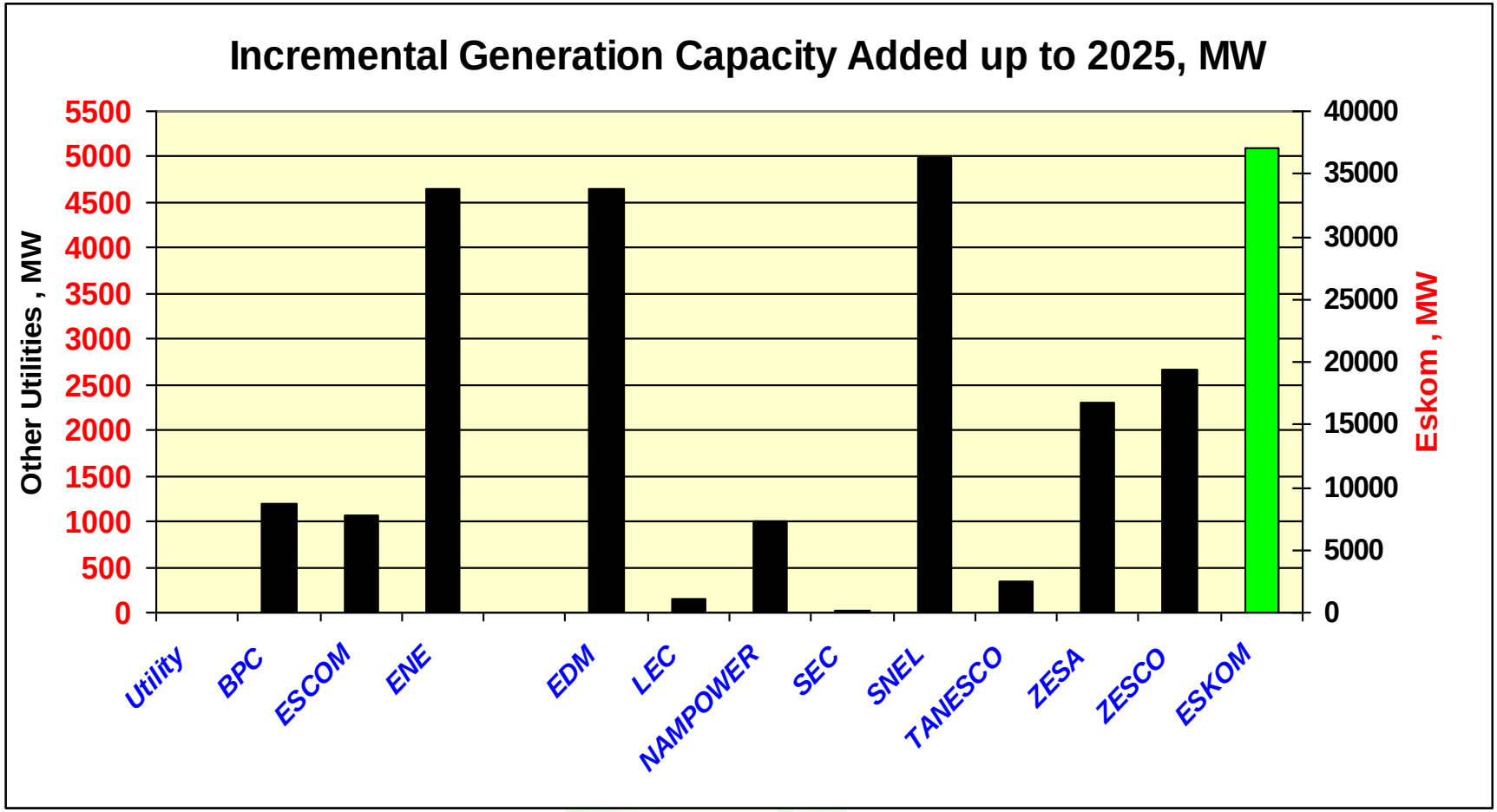
In 2025, a total of 102,871 MW would be required in the SAPP:

✓ Coal	57,415 MW	[55.81%]
✓ Hydro & PS	27,016 MW	[26.26%]
✓ Diesel	13,908 MW	[13.52%]
✓ Natural Gas	2,732 MW	[2.66%]
✓ Nuclear	1,800 MW	[1.75%]

A reduction in coal from 74% to 56% and an increase in hydro from 20% to 26%.

3.1 NEW GENERATION CAPACITY ADDED: 2010 to 2025

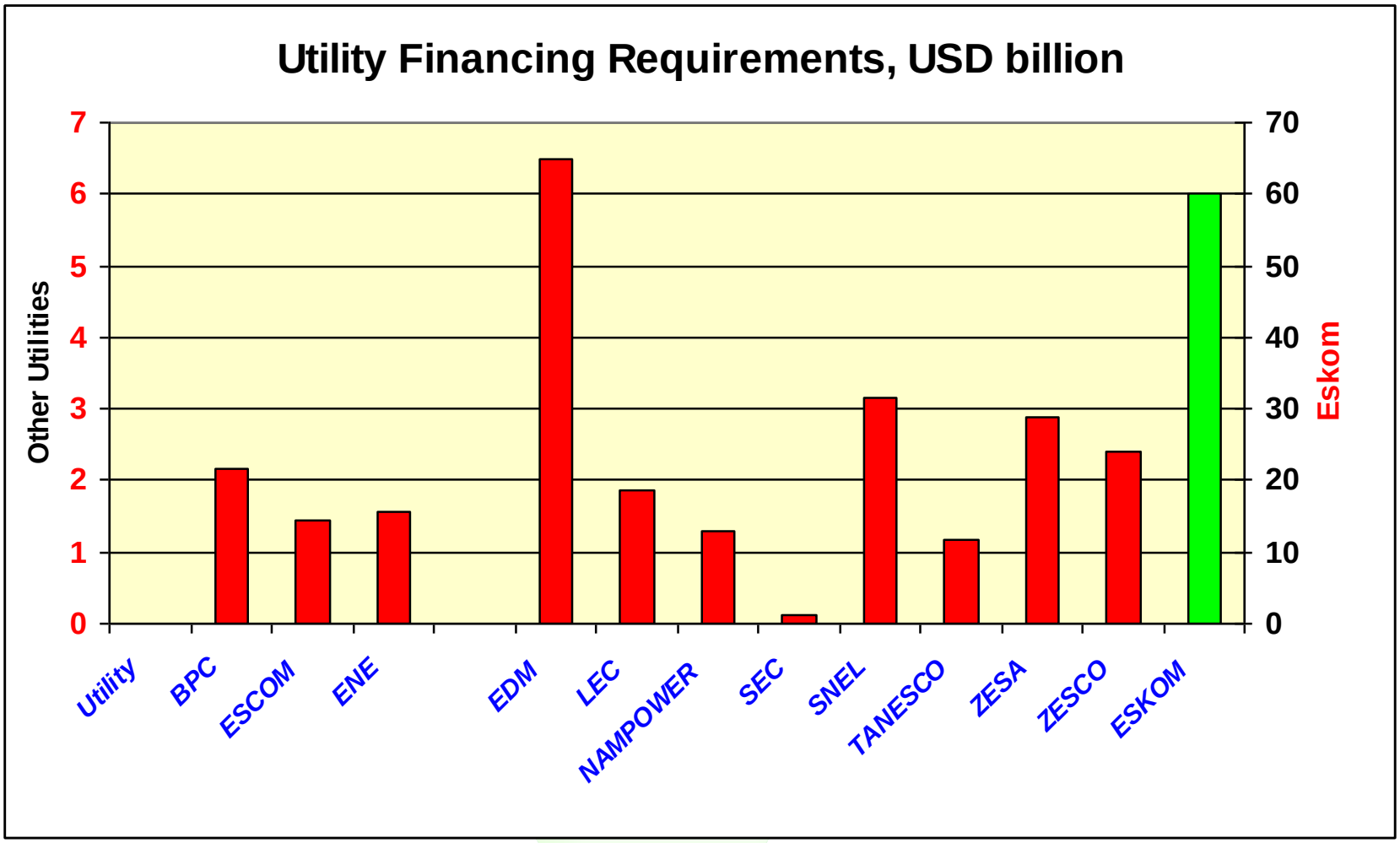
Regional Integrated Expansion Plan



A total of 57,000 MW is added

3.2 FINANCING REQUIREMENTS 2010 to 2025

Regional Integrated Expansion Plan



A total of USD 83 billion is needed

3.3 Planned Hydropower Projects in the SAPP

NO	COUNTRY	PROJECT NAME	CAPACITY MW	EXPECTED DATE
1	DRC	INGA 3	3,500	2017
2	ZIMBABWE/ZAMBIA	BATOKA	1,600	2018
3	MOZAMBIQUE	MPHANDA NKUWA	1,500	2017
4	MOZAMBIQUE	HCB NORTH BANK	1,245	2015
5	LESOTHO	KOBONG	800	2017
6	ZAMBIA	KAFUE GORGE LOWER	750	2017
7	NAMIBIA	BAYNES	500	2017
8	ZIMBABWE	KARIBA SOUTH	300	2015
9	ANGOLA	CAMPAMBE II	180	2012
10	SOUTH AFRICA	INGULA	333	2013
11	ZAMBIA	KARIBA NORTH	360	2013
	TOTAL		11,068	

- ✓ The SAPP plans to increase hydropower contribution from current **20%** to **26%** by 2025 if all planned hydropower projects are implemented.

3.4 Other Planned Hydropower Projects in the Zambezi River Basin

NO	COUNTRY	PROJECT NAME	CAPACITY MW	EXPECTED DATE
1	ZIMBABWE	VICTORIA FALLS S	390	NO DATE
2	ZAMBIA/ZIMBABWE	DEVILS GORGE	1,200	2017
3	ZAMBIA/ZIMBABWE	MUPATA GORGE	1,200	2018
4	MOZAMBIQUE	BOROMA	160	2018
5	MOZAMBIQUE	LUPATA	550	2017
6	MOZAMBIQUE	RUO	100	2017
7	MOZAMBIQUE	LURIO	150	2015

- ✓ The advantage of the **Zambezi river basin** is that it is along the SAPP central transmission corridor and transmission integration would be cheaper to the SAPP compared to the **Congo river basin**.

3.5 COMMITTED GENERATION PROJECTS (NEW & REHAB)

No	Country	Committed Generation Capacity, MW				
		2013	2014	2015	2016	TOTAL
1	Angola	389	640	550	1,246	**2,825**
2	Botswana	600	-	-	300	**900**
3	DRC	55	-	580	-	**635**
4	Lesotho	-	-	35	-	**35**
5	Malawi	64	-	-	-	**64**
6	Mozambique	-	150	300	300	**750**
7	Namibia	-	-	120	50	**170**
8	RSA	923	3,105	2,543	1,322	**7,893**
9	Swaziland	-	-	-	-	**-**
10	Tanzania	60	160	500	1,110	**1,830**
11	Zambia	230	180	435	494	**1,339**
12	Zimbabwe	-	300	30	300	**630**
TOTAL		**2,321**	**4,535**	**5,093**	**5,122**	**17,071**

3 % is Renewable Energy (Wind and Solar) from 2013 to 2016

4. TRANSMISSION PROJECTS

The Alternative case shows that additional facilities would be needed to move power from areas of excess, primarily:

- ✓ **SNEL (DRC),**
- ✓ **EdM (Mozambique) and**
- ✓ **ZESCO (Zambia).**

To areas of shortage, primarily:

- ✓ **Eskom (South Africa) and**
- ✓ **BPC (Botswana).**

PRIORITY TRANSMISSION PROJECTS

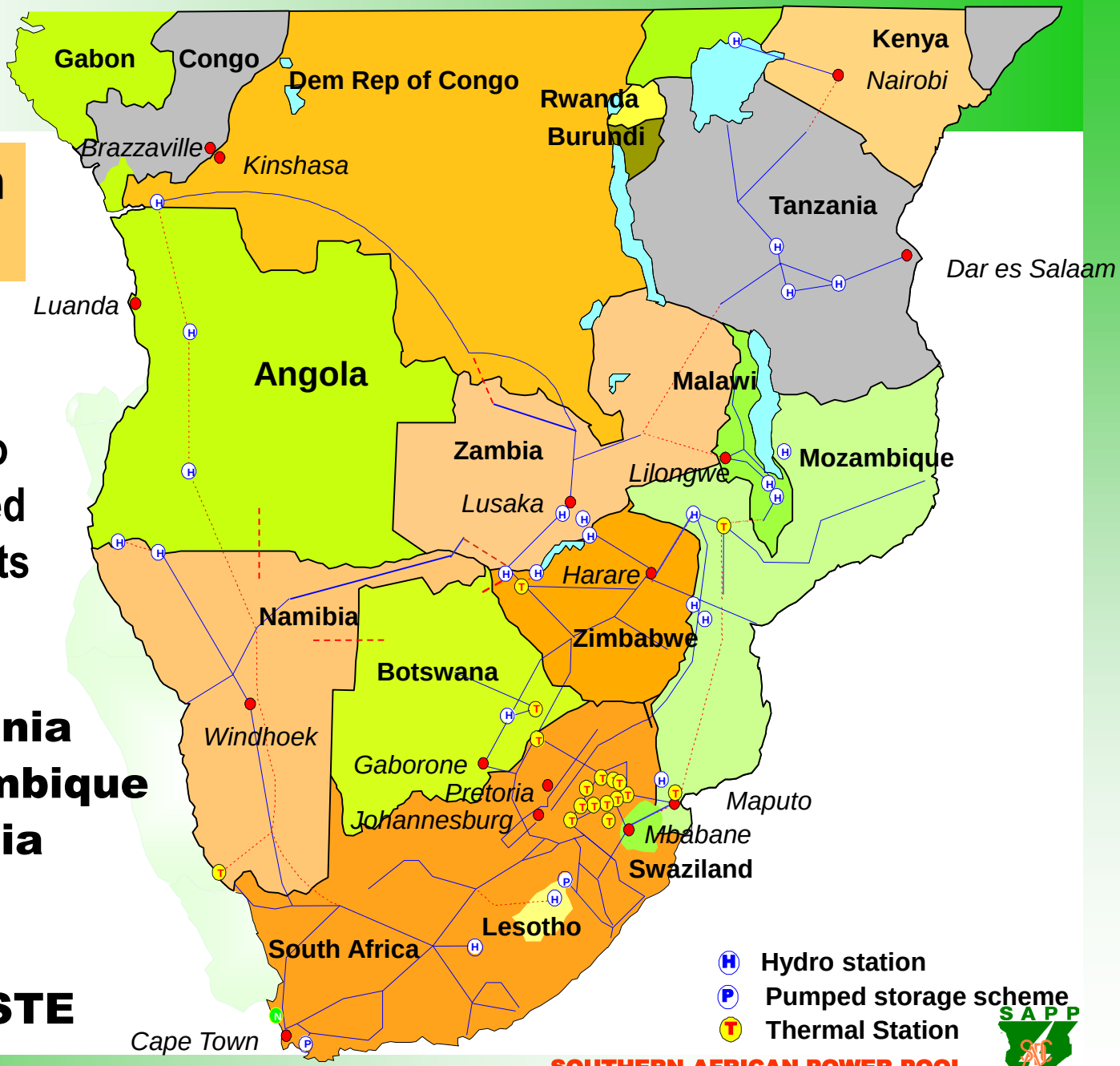
Transmission projects are divided as follows:

- **Outstanding transmission interconnectors whose aim is to interconnect non-operating members of the SAPP:**
  - **Mozambique-Malawi interconnector,**
  - **Zambia-Tanzania-Kenya Interconnector, and**
  - **Interconnection of Angola.**
- **Transmission interconnectors aimed at relieving congestion on the SAPP grid, and**
- **New transmission interconnectors aimed to evacuate power from generating stations to the load centres.**

Transmission Projects

Over **USD 5.6 billion** would be required to develop the identified transmission projects

- **Zambia-Tanzania**
- **Malawi-Mozambique**
- **Angola-Namibia**
- **ZIZABONA**
- **CTC**
- **Mozambique STE**



SOUTHERN AFRICAN POWER POOL

5. TECHNICAL & ECONOMIC PARAMETERS AFFECTING INTEGRATION OF RENEWABLE ENERGY

a. The successful integration of renewable energy resources requires:

i. **Supporting government policies & regulatory frameworks,**

ii. **Sustainable tariffs and favourable economics, and**

iii. **The proper application of technology.**

Government policies:

- ✓ **Establish locations for siting renewable resources that may be necessary to successfully integrate these resources.**
- ✓ **Should be consistent over time & should provide incentives to developers.**

5. TECHNICAL & ECONOMIC PARAMETERS AFFECTING INTEGRATION OF RENEWABLE ENERGY

b. The following technical considerations should be considered when integrating renewable energy into the SAPP grid:

i. capacity factor,

ii. voltage control capabilities,

iii. tolerance to voltage dips resulting from contingencies,

iv. ability to help regulate the system for frequenting variations,

v. acceptable flicker and harmonise emission performance, and

vi. other capability functions.

6. CONCLUSION

i. Most renewable energy in the SAPP is from hydro.

ii. Efforts are being made to include solar and wind in the SAPP Generation mix by 2016.

iii. Governments in SADC are still developing policies and regulatory frameworks on how to deal with RE:

- ✓ The commitment of nuclear energy in South Africa is a policy choice rather than economic.

iv. SAPP plans to decrease coal generation from 74% to 56% and increase hydro and other RE generation (including hydro) from 20% to 27% by 2025.

THANK YOU