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IRENA EXECUTIVE STRATEGY WORKSHOP
AFRICA CLEAN ENERGY CORRIDOR INITIATIVE
Abu Dhabi, 22-23 June 2013

CURRENT PLANS FOR REGIONAL TRANSMISSION REINFORCEMENTS IN SOUTHERN AFRICA

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Contents

- **BRIEF RECAP OF CURRENT INTERCONNECTION STATUS**
- **PLANNING PROCESS IN SAPP**
- **MOTIVATIONS FOR CURRENT TRANSMISSION PLANS**
- **BUSINESS MODELS FOR TRANSMISSION DEVELOPMENT**
- **CHALLENGES AND FURTHER WORK**

The objective of the presentation is to provide an assessment of the requirements for transmission reinforcement in the SAPP. The presentation starts with a brief recap of the current interconnection status and planning process – the detail provided by SAPP.

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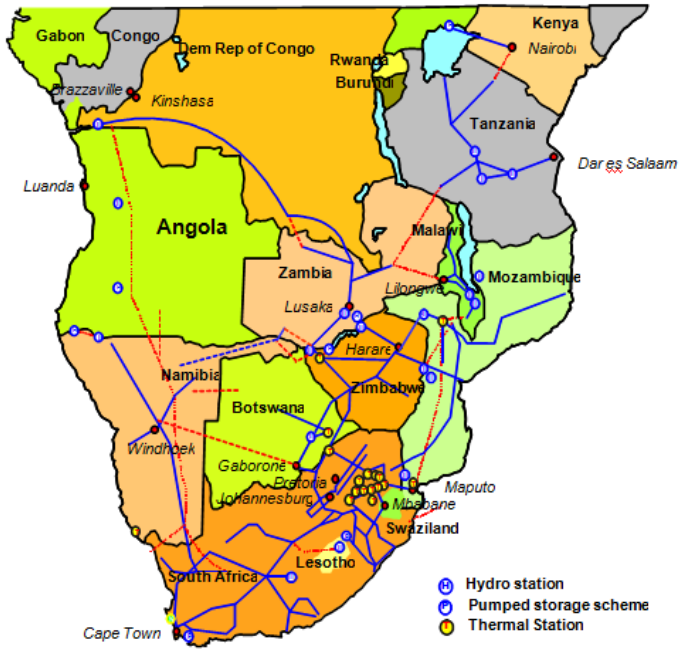
SAPP Interconnection map



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Existing interconnections were largely inherited from pre-SAPP days. These were mainly bilateral projects for firm, economy and emergency power purchases. These bilateral contracts still account for the bulk of the power trade.

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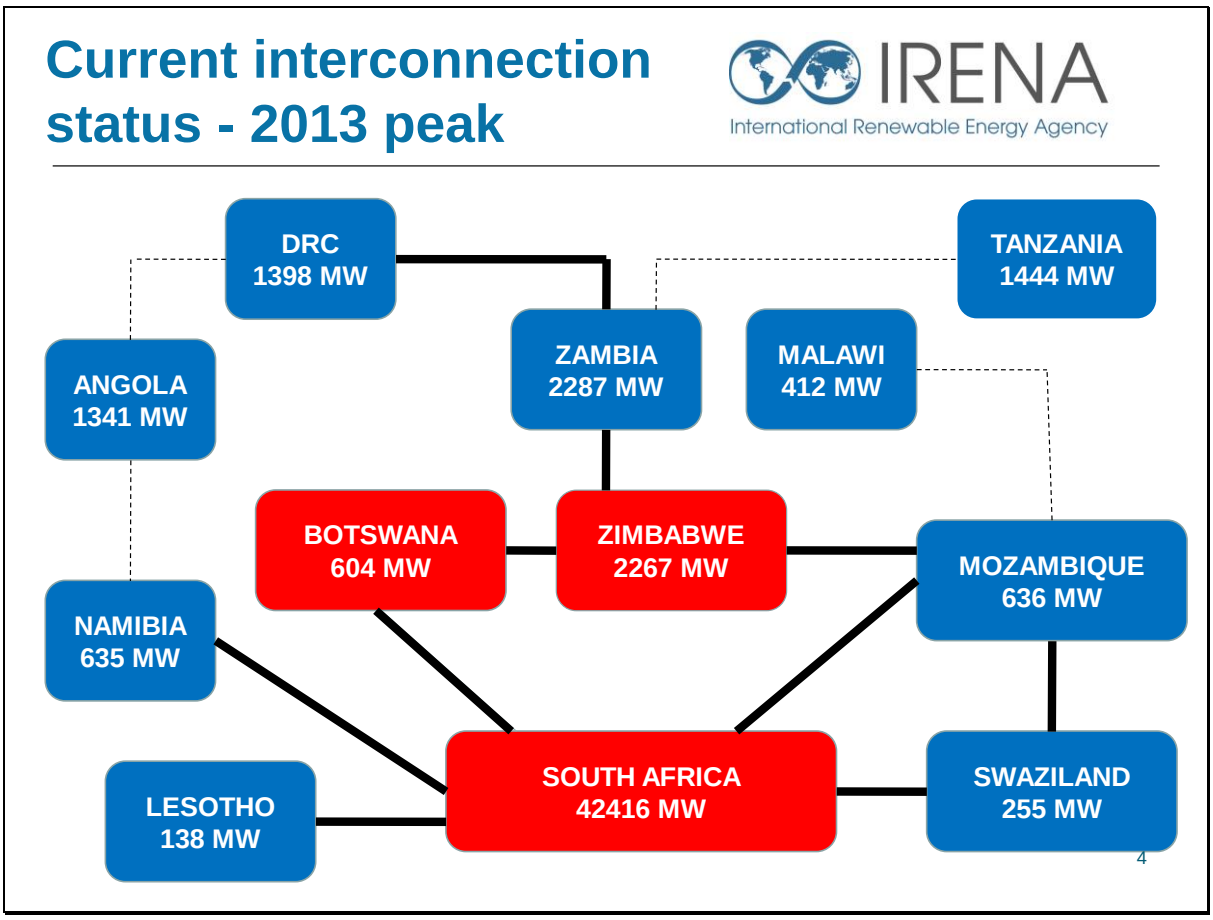

Blue is for countries with at least 50% to 100% hydro base load; red is for countries with more than 50% fossil fuel generation (mainly coal); Angola, Malawi and Tanzania are not yet interconnected. SAPP's main achievements have been to (1) to establish a forum for coordinated planning and operation of the generation and transmission networks, (2) use existing interconnectors to create a complimentary energy market – STEM and DAM – and (3) provide capacity building for operating and maintaining the national and regional grids.

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Current generation capacity and demand (April 2013)

Country	Installed capacity		Peak demand*		Available capacity		
	MW	% All	MW	% All	MW	% All	% Peak
S. Africa	44 170	77	42 416	79	41 074	79	97
Others	13 012	23	11 417	21	10 628	21	93
Total	57 152	100	53 833	100	51 702	100	96

* Peak demand includes suppressed demand and reserves.

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South Africa accounts for nearly four fifth of capacity and demand. Available capacity in SADC is currently below that required to meet peak demand and reserve margins. Current plans are therefore dictated by South Africa's requirements, the need to resolve the regional capacity deficit and the need to have all 12 member countries interconnected.

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Planning process in SAPP

Current Process: Multi-criteria project prioritisation

- Each national utility submits to SAPP a government approved generation and transmission plan for their country.
- SAPP Coordination Centre compiles list of projects from the different national plans and uses approved selection criteria to rank the projects.
- The projects that score above 50% are accepted as SAPP Priority Projects by SAPP Executive and presented to the SADC Energy Ministers for endorsement.

Endorsed projects are the ones promoted for investment at regional forums. Major weakness of this prioritisation system is relying on national plans that are at very different level of detail. The RSA IRP has gone through a rigorous stakeholder consultation process that none of the other countries have gone into. There is also information asymmetry among the options – e.g. Costs are either based on feasibility or prefeasibility studies or are simply based on expert judgment

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Planning process in SAPP

Pool Plans (2001 & 2009) have not been formally adopted for the following reasons:

- Major assumption of unconstrained free trade is deemed unrealistic as this grossly underestimates national political and social factors
  e.g. national security, local job creation

- Inadequate risk assessment for the different options, countries are naturally risk averse
  e.g. they all want to be self-sufficient or net exporters and to import using their own currencies

Shortcomings of Pool Plans. Natural bias is towards self-sufficiency. To be a net exporter will be an added advantage. Risks include uncertainties of technology such as accuracy level of cost estimates, estimation of lead times, security of fuel supply, operational risks.

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Planning process in SAPP

Proposed Pool Plan Review Process:

- Adoption of agreed planning criteria and assumptions, especially the SAPP load forecast
- Modelling scenarios based on the planning assumptions
- Determination of the optimum plan
- Approval of the SAPP Plan by the SAPP Executive Committee
- Approval by the SADC Energy Ministers

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SAPP documents talk of a "Least cost" plan but this should read "optimum plan". Individual government policies will form part of the input parameters and assumptions e.g. desired generation mix, renewable energy contribution, demand side management and energy efficiency requirements and security of supply requirement.

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SAPP Current vs 2009 Plan Projections – Total Generation Mix (%)

Generation type	South Africa	Other countries	Current SAPP (57GW)	Pool Plan 2025 (103 GW)
Hydro	5	74	17	26
Coal	86	18	73	56
Nuclear	4	-	4	2
OCGT	-	6	1	3
Distillate	5	2	5	13
Total	100	100	100	100

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This gives an indication of where we are now and where the 2009 Pool Plan forecasts for 2025 if the plan had been adopted. The Plan avoids new nuclear for cost reasons and raises trade, mainly from large hydro power plants, 14 TWh/yr (uncoordinated national plans) to 36 TWh/yr trade, which requires HVAC transmission voltages to increase from maximum 400 kV to 765 kV. Non-hydro renewables were not considered in the 2009 Plan. The OCGT and Distillate are for peaking and mid-merit dispatch for normal or emergency situations respectively - uncertainty in future costs

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SAPP Generation Project prioritisation

Criteria	Weight	Best if
Levelised cost	20	Low
% Regional contribution	15	High %
Size of project	10	>1000 MW
Regional economic impact	10	High
Project lead time	10	Short
% off-take committed	10	High %
Climate change impact	10	Low
Cost of transmission	10	Low
# of Participating countries	5	>5

The criteria marked in red favour large hydro projects – hence the top 4 ranked projects are 3 large hydro projects on the Zambezi (HCB north, HMNK and Batoka), followed by Inga 3 on the Congo which is ranked lower due to cost of transmission.

SAPP documents talk of a "Least cost" plan but this should read "optimum plan".

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Generation Capacity Additions: SAPP vs 2009 Plan

Technology of additional Generation	SAPP (%) 55673 MW	2009 Plan (%) 56686 MW
Hydro	28	32
Coal	16	42
Nuclear	17	-
Gas & distillate	13	26
Renewable (non-hydro)	26	-
Total	100	100

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The influence of the national plans on renewable energy is significant, especially the impact of the South African Integrated Resource Plan. Most of the non-hydro renewables are in South Africa (wind and solar). The Pool Plan did not take non-hydro renewables into account

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South Africa – 2010 IRP Criteria

Criteria	Weight	Best scenario
CO2 Emissions	21.74	Least emissions
Investment cost	21.74	Least-cost (base case)
Technology uncertainty	19.57	Proven technology
Localisation potential	15.22	Maximum localisation benefits
Water usage	10.87	Water conservation
Regional development	10.87	Maximum imports from region
Multi-criteria	100	Optimum balance of the above

The Plan is optimised using a multi-criteria approach rather than just a least-cost basis. The recommended plan is an optimum balance of all the criteria, adjusted to meet policy decisions such as acceleration of the renewable energy projects

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South Africa – 2010 IRP (2010-2030)

Planned new generation by 2030		GW	%
Coal		6.3	15
Nuclear		9.6	22
Renewables	Hydro import	2.6	6
	Solar	8.4	20
	Wind	8.4	20
	CSP	1.0	2
Other	Gas turbines	6.3	15

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South Africa's future generation plans have a major impact on planned transmission investments in the region – current plans place a restriction on import dependency. Most of the renewable capacity is within South Africa – transmission reinforcements within S Africa rather than the regional grid. Nuclear is the insurance for uncertainties in the cost of renewables and fuels. TARIFF impact is expected to be mainly due to uncertain coal costs. Gas turbines are peaking plant expected to contribute only 0.3% to total 2030 costs. Minimum CO2 scenario which has the most renewables increases the investment costs from ZAR789billion (2010 costs) for base case to ZAR1250 billion (ZAR10=US$1 now and in 2010).

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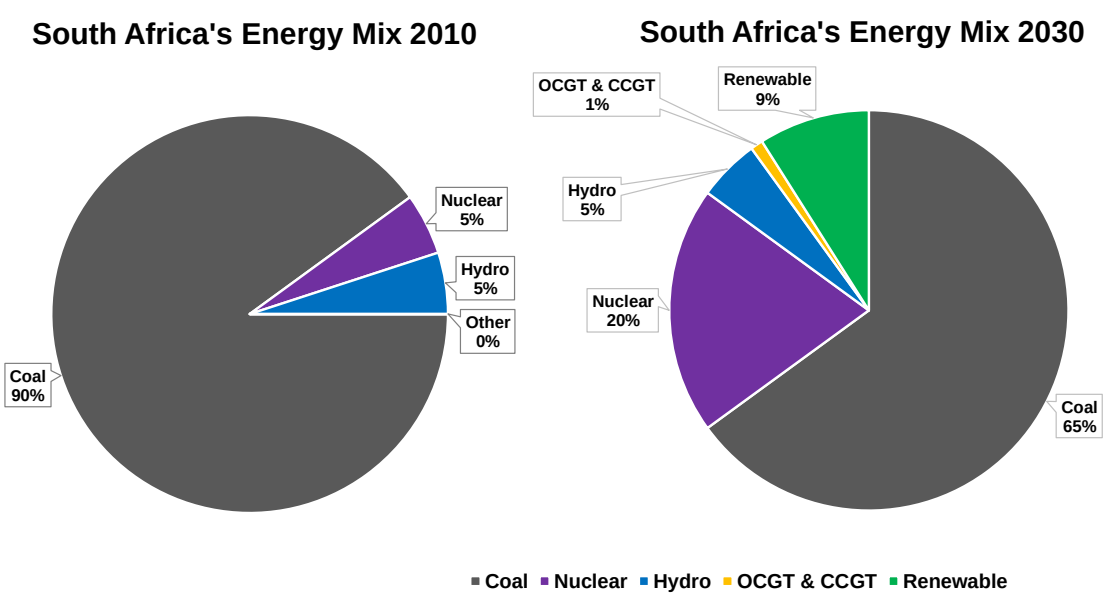

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Main goals and purpose of current transmission plans

- Interconnecting the non-operating members – Angola, Malawi and Tanzania.
- Strengthening transmission corridors to facilitate energy trading, especially DAM.
- Evacuating power from new generation: Zambezi basin & Inga plus South African grid.

The second and third bullet points are inter-related because the transmission corridors for increasing energy trading must address both short term and long term bilateral contracts

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Impact of transmission constraints on energy traded

- More than 95 % of current trading in SAPP is through bilateral contracts:
  interconnectors optimised for original contracts.

- Short-term energy market (STEM) and now Day ahead market (DAM) restricted to less than 5%:
  transmission congestion a major constraint.

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DAM: mismatched prices and transmission constraints; without transmission congestion many traders would be prepared to revise prices to allow trade.

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Impact of transmission constraints on energy traded on DAM

Year		Potential market (GWh)	Energy traded (GWh)	Energy not traded (GWh)
2009 - 2010		0.5	0.5	-
2010 - 2011		44.4	27.4	17.0
2011 - 2012		21.8	10.4	11.4
Total	GWh	66.7	38.3	28.4
	%	100	57	43

Source: SAPP Annual Report 2012

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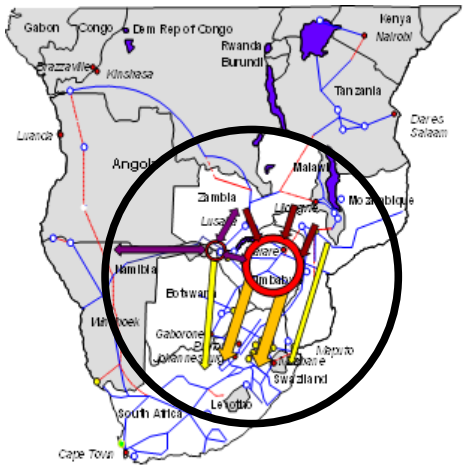
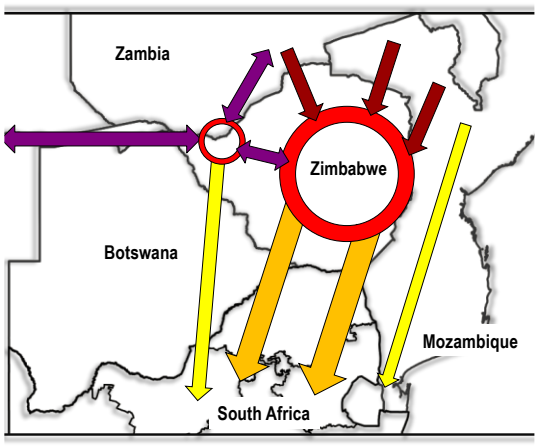
STRATEGIC NETWORK CONCEPT





Evacuating power from the Zambezi basin to South Africa

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Strategic network is designed to relieve transmission congestion. It comprises a super ring centred in Zimbabwe which is capable of fulfilling internal requirements plus wheeling of power from DRC, Zambia, Malawi and Mozambique to South Africa (and hence all the countries interconnected to South African grid – Namibia, Botswana, Lesotho and Swaziland; Smaller ring around ZIZABONA creates another route into South Africa plus grid for trading among Zimbabwe, Zambia, Botswana, Namibia and Angola

The eastern yellow line is the Mozambique backbone project; the western double arrow line is the ZIZABONA project. The western yellow line is an alternate to deal with central transmission corridor emergencies.
Small ring: Kafue –Livingstone, ZIZABONA, North-west Botswana.

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Business Models for Transmission

- **PUBLIC UTILITIES:**
  Fund most of the existing generation and transmission in SAPP. The national utilities are government owned.

- **SPECIAL PURPOSE VEHICLES (SPVS):**
  e.g. MOTRACO (Mozambique Transmission Company) jointly owned by S. Africa, Mozambique and Swaziland which built and operates the 400 kV line to the aluminium smelter, Mozal.

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Business Models for Transmission

- **PRIVATE SECTOR:**
  Copperbelt Energy Corporation of Zambia is a model for a private sector owned transmission company. Transmission assets formerly public owned.

- **PUBLIC-PRIVATE PARTNERSHIPS:**
  PPP SPVs planned for Mozambique backbone (STE), ZIZABONA, Western Corridor (WESTCOR).

These are initially being planned as government controlled joint ventures which are subsequently privatised.

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Business Models for Transmission

- Prices for bilateral projects are negotiated on a willing buyer and willing seller basis.
- Transmission charges for STEM and DAM trading have been based on the MW-km method.
  - An alternative nodal transmission pricing method is still under study – standard prices are established for defined zones (gives better market signals for investment).
- Transmission lines are easier to build on the predictable revenue of the bilateral or multilateral contracts.

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MW-km prices depend on amount of power and distance between buyer and seller. Price is based on marginal cost of losses and rental charge dependent on the replacement cost and depreciated value and proportion of use of the transmission assets used in the trade. Zonal transmission costs are recovered through market determined entry and exit charges by sellers and buyers. When there is congestions the zone is split into different price areas - provides market signals for new investment because congested areas attract higher prices.

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Challenges and further work

- Achieving regional consensus on planning criteria and methodology - preferably national plans that compliment regional plans.
- Research to minimise uncertainty (=risk) for all technology options: e.g. cost, project lead times, equipment life times, environmental impact
- Harmonisation of regional, inter-regional and continental coordinating initiatives: e.g. streamlining institutional framework
- Capacity building – planning models, demand forecasting, renewable energy integration, transmission pricing, cross-border project negotiation, O&M.
- National plans should compliment the regional plans.

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Regional consensus is a delicate balance between competing interests – multi-criteria. National bias towards self-sufficiency, net exporter and use of local currencies for import. Cost and environmental issues are not enough motivation. Perceptions of risk – investment required to get feasibility level information for the options that need to be considered for planning.
Transmission planning process is intimately linked to the generation planning process. We have to start by understanding the generation planning process first. 2009 Plan showed that coordinated investment would cost US$89.3 billion (2006$) compared to US$136.8 billion for national plans (saving of US$47.5 billion or 35%).

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THANK YOU FOR YOUR ATTENTION!

Questions & Answers…