The Infrastructure Consortium for Africa

UPDATED REGIONAL POWER STATUS IN AFRICA POWER POOLS REPORT

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Infrastructure Consortium for Africa (ICA)
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The Infrastructure Consortium for Africa Secretariat
c/o African Development Bank
CCIA Building
P.O. Box 1387
Abidjan, Ivory Coast
www.icafrica.org

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1. West African Power Pool (WAPP) Secretariat
    - Siengui A. Si.
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    - Lebbi Changullah.
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    - Allison Chikova.
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Acronyms

ACP	African, Caribbean and Pacific
AFREC	African Energy Commission
Bn	Billion (1,000,000,000)
CAPP/PEAC	Central African Power Pool/ Pool Energé que de l'Afrique Centrale
CAR	Central Africa Republic
CEO	Chief Executive Officer
COMELEC	Comité Maghrébin de L'Electricité (Maghreb Electricity Committee)
COMESA	Common Market for Eastern and Southern Africa
CPE	Commission for Planning and Studies
DAM	Day Ahead Market
DRC	Democratic Republic of Congo
EAC	East African Community
EAPP	Eastern Africa Power Pool
ECCAS	Central African States
ECOWAS	Economic Community for West African States
EDF	European Development Fund
EU	European Union
GDP	Gross Domestic Product
GEIDCO	Global Energy Interconnection Development and Cooperation
GW	Giga-watt (1,000 mega-watts)
GWh	Giga-watt-hours (1,000 MWh)
ICA	Infrastructure Consortium for Africa
IEA	International Energy Agency
IGMOU	Inter-Governmental Memorandum of Understanding
IRENA	International Renewable Energy Agency
Km	Kilometre (1,000 metres)
kW	Kilo-watt (1,000 watts)
kWh	Kilo-watt hour (1,000 Watt-hour)
MDG	Millennium Development Goals
MOU	Memorandum of Understanding
MW	Mega-watt (1,000 kilo-watts)
OECD	Organization for Economic Co-operation and Development
OMVG	Gambia River Basin Development Organisation
OMVS	Senegal River Basin Development Organisation
ONE	Office National de l'Electricité of Morocco
PIDA	Programme for Infrastructure Development in Africa
PPI	Private Participation in Infrastructure
PRB	Population Reference Bureau
REC	Regional Economic Community
RSMO	Regional System Market Operator
SADC	Southern African Development Community
SAPP	Southern Africa Power Pool
SE4ALL	Sustainable Energy for All
SONELGAZ	Société Nationale de l'Electricité et du Gaz of Algeria
SSA	Sub Saharan Africa
STEG	Société Tunisienne de l'Electricité et du Gaz of Tunisia
T&D	Transmission and Distribution
TICAD	Tokyo International Conference on African Development
TWh	Terra-watt-hour (1,000,000 GWh)
UMA	Union of Maghreb area
UN	United Nations
UNECA	United Nations Economic Commission for Africa
USD	United States Dollar
WAPP	West African Power Pool

Executive Summary

1. Introduction

In November 2011, the ICA published a report entitled "Regional Power Status in African Power Pools" that provided an overview of the status of Africa's five Regional Power Pools - the Eastern Africa Power Pool, the Central African Power Pool, the Southern African Power Pool, the West African Power Pool and the Comité Maghrébin de l'Electricité using baseline data from between 2008 and 2010.

This Updated Report provides the status of the five Power Pools based on data for the period between 2013 and 2015.

2. Objectivte

As part of its mandate to increase knowledge and information sharing, ICA carried out an update of the 2011 Report in order to provide updated data on the energy sector.

3. Key Findings

Based on the study findings, there has been growth in the power sector across the African continent since the publication of the 2011 Report; the progress in each power pool is outlined below:

1. **EAPP**: with a membership of 11 countries, has attained a growth in the installed capacity from 38,513 MW and the corresponding consumption of 162,322 GWh in and 2008 to 54,311 MW and 232,505 GWh in 2013 respectively.

   Based on the proposed roadmap, the attainment of a centralised trading regime may occur between 2020 and 2025.

2. **WAPP:** with a membership of 14 countries, WAPP has attained a growth in the installed capacity from 14,669 MW in 2008 to 19,648 MW in 2015. And the corresponding consumption increased from 46,936 GWh in 2008 to 50,634 GWh in 2015 respectively.

   Based on the proposed roadmap, the attainment of a centralised trading regime may occur by 2019 subject to the completion of the regional interconnection projects.

3. **SAPP:** with a membership of 11 countries, has attained a growth in the installed capacity from 55,948 MW and the corresponding consumption of 260,081 GWh in and 2008 to 61,859 MW and 269,375 GWh in 2015 respectively. The Southern African Power Pool (SAPP) was created in 1995 and is now the most advanced power pool on the continent; given the developments taking place in the region, it is expected that more countries will be operational members by the end of 2018, and there will also be an interconnection between EAPP and SAPP.

4. **CAPP:** with a membership of 10 countries, has attained a growth in the installed capacity from 5,345 MW and the corresponding consumption of 15,238 GWh in 2008 to 6,299 MW and 24,744 GWh in 2013 respectively.

   Given the developments in the region, it is probable that by end of 2020, CAPP may start functioning as a Power Pool for the interconnected countries.

5. **COMELEC:** with a membership of 5 countries, has attained a growth in the installed capacity from 24,027 MW and the corresponding consumption of 160,322 GWh in 2009 to 36,367 MW and 120,200 GWh in 2013 respectively.

   Given the enhanced support to regional power development, COMELEC could start its operations as a Power Pool as early as late 2018; but this depends more on political rather than technical considerations.

4. Challenges

While in general there has been commendable progress, the key challenges include:

- **Lack of infrastructure:** the need for infrastructure requires no over-emphasis as no power trade/exchange can take place without the necessary infrastructure in place:

- **Lack of national strategies:** Many countries still lack a comprehensive strategic framework in the context of national goals and objectives to help guide the roles and responsibilities for all players including government utilities, the private sector, civil society and development organisations;

- **Utility financial distress:** These are mainly attributed to below-cost tariffs, weak management and political interference; and

- **Politics:** The ultimate goal to harness energy resources for the socio-economic transformation of Africa will necessarily hinge on political will and support. The need to harmonise power sector regulatory policies and the adoption of regional master plans to guide national development plans cannot be compromised.

5. Conclusion

The Continent needs to sustain the commendable positive trend, and for this the countries should continue to:

- Mobilise investments for physical intra-regional infrastructure - this should include agreeing on strategies for the mobilisation of domestic resources such as pension funds and infrastructure bonds;

- Provide conducive legal and regulatory frameworks for private sector participation - this should include legally empowering the power pools to act on behalf of RECs (and governments), particularly on power deals;

- Continue strengthening the institutional capacity and skills of the power pools and directorates in charge of energy in the RECs – with a focus on enhancing the capacity and skills for structuring and negotiating power deals with the private sector; and

- Take necessary measures to enhance the role of the private sector.

Chapter 1
Introduction to the Report

1.1 Background

In November 2011, the ICA published a report entitled "Regional Power Status in African Power Pools" that provided an overview of the status of Africa's five Regional Power Pools - the Eastern Africa Power Pool (EAPP), the Central African Power Pool (CAPP), the Southern African Power Pool (SAPP), the West African Power Pool (WAPP) and the Maghreb Electricity Committee (or Comité Maghrébin de l'Electricité, COMELEC) using baseline data from between 2008 and 2010.

The ICA's Strategic Business Plan for the three-year period 2014 to 2016 includes a section on "Increased Knowledge and Information Sharing". As one of its activities in this area, the ICA Secretariat produced this Report that provides an update of the 2011 Report; it includes:

1. Updated data on the energy sector in Africa;

2. Extensive analysis of data, identifying findings, trends and possible solutions for the respective regions of the five Power Pools, and the potential to build effective power markets in the regions (an element that was not exhaustively addressed in the 2011 report);

3. A section on private sector participation.

This Report is based on data collected from the following:

- Data collected from 3 Power Pools, EAPP, WAPP and SAPP during physical site visits undertaken by the consultant during October and November 2016;
- Published data sources include AFREC, UN, World Bank and the International Energy Agency's World Outlook 2015 database. Due acknowledgement has been indicated in the text; and
- Other sources as indicated in the list of references.

1.2 Outline of the report

This report is divided into six chapters. Chapter 2 provides a review of East African Power Pool. Chapter 3 discusses the West African Power Pool. Chapter 4, 5, and 6 reviews the various the status of the Southern African Power Pool, Central African Power Pool, and Maghreb Electricity Committee respectively. Chapter 7 provides the analysis of power pool data, challenges along with the recommendation.

Chapter 2
Eastern Africa Power Pool (EAPP)

Box 1: EAPP trends

The Eastern Africa Power Pool, established in 2005 by 7 member countries, had by 2013 grown to cover 11 countries with an estimated population of 450 million, while its installed capacity has increased from 38GW in 2008 to 55GW in 2013. While the region is well endowed with natural resources with respect to electricity generation, varying from hydro in Ethiopia and Uganda, geothermal in Kenya and gas in Tanzania, most of this remains undeveloped and electrification rates in these countries vary from 2% in Burundi to 40% in Ethiopia.

The EAPP has made commendable progress towards formation of a power pool by undertaking a Master Plan in 2011. This was updated in 2014 but it still faces a number of challenges, including:

1. Limited power trade among countries due to a lack of interconnections;
2. Weak alignment of national development plans with the regional Master Plan;
3. Weak incentives for private sector participation; and
4. Inadequate reliable data.

It is expected, however, that if current developments are sustained, demand will increase to about 500TWh by 2030 with Egypt accounting for more than 75% of the total installed capacity. The total required investment will amount to about USD$ 400 billion to meet the demand.

2.1 Introduction

The Eastern Africa Power Pool (EAPP) was established in 2005 with the signing of an Inter-Governmental Memorandum of Understanding (IGMOU) by seven Eastern Africa countries, namely: Burundi, Democratic Republic of Congo (DRC), Egypt, Ethiopia, Kenya, Rwanda and Sudan. In a further development, the EAPP was adopted as a specialised institution to foster power system interconnectivity by the heads of states of the Common Market for Eastern and Southern Africa (COMESA) region in November 2006. Later Tanzania, Libya and Uganda joined EAPP in March 2010, February 2011 and December 2012 respectively; Djibouti is the latest entrant.

2.2 Vision

To facilitate and secure power supply to the countries of the Eastern Africa region at the lowest possible cost.

2.3 Objectives

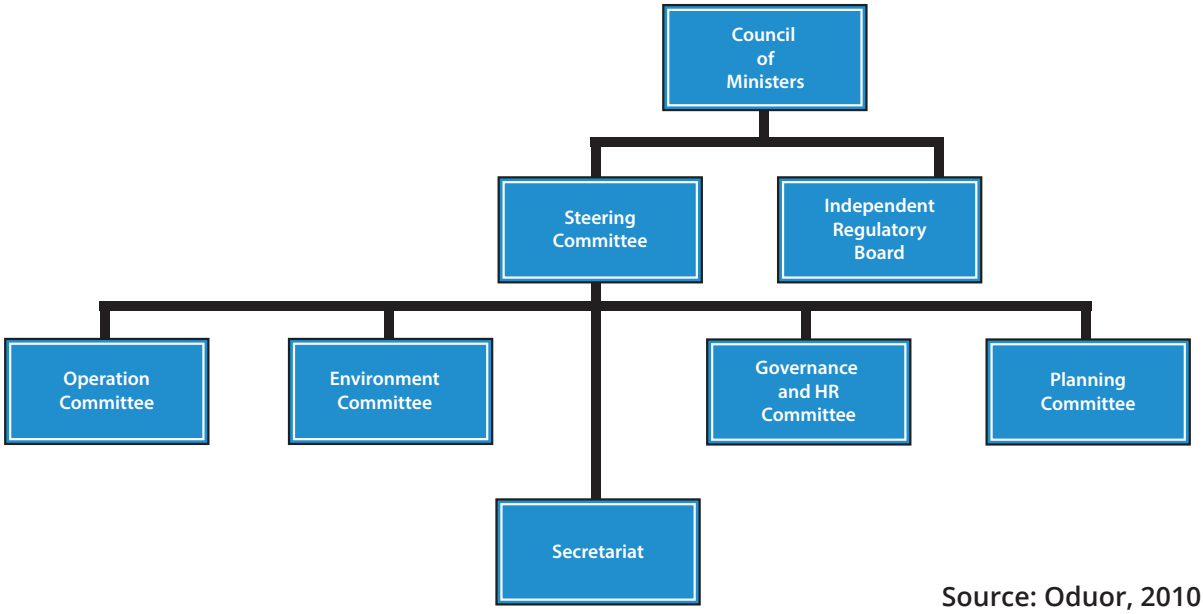
- To be a framework for pooling energy resources, promoting power exchanges between utilities in Eastern Africa and reduce power supply costs based on an integrated master plan and pre-established rules (Grid code);
- Optimise the usage of energy resources available in the region by working out regional investment schemes in power generation, transmission and distribution;
- Reduce electricity costs in the region by using power systems interconnection and increasing power exchanges between countries; and
- Provide efficient co-ordination between various initiatives taken in the fields of power production, transmission as well as exchanges in the Region.

2.4 Membership

The current membership consists of the following eleven (11) countries Burundi, Democratic Republic of Congo (DRC), Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, Libya and Uganda; and the latest addition Djibouti. Based on information from the EAPP Secretariat, South Sudan is expected to become a member soon.

2.5 Governance

The EAPP has four (4) governing bodies: the Council of Ministers, the Steering Committee, the Organisational Committees and the General Secretariat; as illustrated in the Figure 1 below:



Source: Oduor, 2010

Figure 1: Organisation chart EAPP

2.6 Socio-economic background

The GDP of the countries is as indicated in Table 1 shows that Egypt is well above the other members in the region in terms of economic performance. This is followed (at a considerable distance) by Ethiopia, Kenya and Sudan and this correlates positively with the electricity demand see Table 4, 5 and 8.

	Year 2010		Year 2013	
	GDP (US$ Bn)	GDP per Capita ($)	GDP (US$ Bn)	Population (Million)
Burundi	2	228	3	10.9
Djibouti	1	1,411	2	0.9
DRC	21	309	35	71.1
Egypt	219	2,922	331	84.7
Ethiopia	30	378	62	89.2
Kenya	40	1,053	63	44.2
Libya	75	11,869	29	6.5
Rwanda	6	594	8	11.1
Sudan	66	1,666	84	34.2
Tanzania	31	781	45	49.1
Uganda	20	691	26	36.9

Source: World Bank database, 2013; PRB database 2010, 2013

Table 1: Socio-economic data of EAPP member countries

2.7 Overview of the energy sector

2.7.1 Installed generation capacity

The installed generation capacity in the region has increased from roughly about 39,000MW in 2008 to about 54,000MW in 2013; an increase of about 38%; see Table 2 below for more details. Based on the available information, the increment in installed capacity is due to a number of factors that include the increased capacity to meet demand due to GDP growth, global initiatives like SE4ALL that aim at universal access to modern energy services by 2030 and increasing regional power trade.

Country	2008	2013 *	% change
Burundi	33	42	27
Djibouti	130	130	0
DRC	2,476	2,506	1
Egypt	24,185	32,702	35
Ethiopia	878	2,311	163
Kenya	1,326	1,723	30
Libya	6,612	9,455	43
Rwanda	56	109	95
Sudan	1,268	3,117	146
Tanzania	1,010	1,380	37
Uganda	539	836	55
Total	38,513	54,311	41

Source: UN data-base, 2013

Table 2: Installed capacity (MW)

2.7.2 Production

The production as indicated in the Table 3 shows that there is correspondingly general increase of power generation over the period across all member countries in varying degree; with Ethiopia and Sudan presenting the highest increments.

2.7.3 Consumption

In line with the increased production, the consumption has increased in each of the countries as shown in Table 4 below supporting the positive correlation between energy demand and GDP growth (refer to the Table 1).

Country	2010	2013
Burundi	241	184
Djibouti	325	82
DRC	7,600	8,391
Egypt	146,795	157,930
Ethiopia	4,931	8,461
Kenya	7,467	8,989
Libya	32,753	31,183
Rwanda	280	769
Sudan	8,009	11,870
Tanzania	5,080	6,051
Uganda	2,406	3,207
Total	215,887	237,117

Source: AFREC, 2015

Table 3: Generation (GWh)

Country	Consumption in 2008 (GWh)	Consumption in 2013 (GWh)
Burundi	61	271
Djibouti	243	341
DRC	7,489	7,876
Egypt	106,558	155,596
Ethiopia	3,238	7,633
Kenya	5,377	8,579
Libya	28,396	31,295
Rwanda	177	769
Sudan	4,285	11,862
Tanzania	3,292	6,136
Uganda	1,206	2147
Total	160,322	232,505

Source: AFREC, 2015

Table 4: Consumption in EAPP countries

2.7.4 Consumption per capita

In line with the GDP growth Table 1 and supported by the availability of more capacity Table 3; correspondingly the consumption per capita also increased - Table 5.

Country	Consumption per capita in 2008 (kWh)	Consumption per capita in 2013 (kWh)
Burundi	7	25
DRC	113	111
Djibouti	304	379
Egypt	1,423	1,837
Ethiopia	41	86
Kenya	142	194
Libya	4,507	4,185
Rwanda	18	69
Sudan (excluding South Sudan)	109	347
Tanzania	82	125
Uganda	41	58

Source: AFREC, 2015

Table 5: Consumption per capita in 2013

2.7.5 Imports and Exports

Some increase has been registered as shown in Table 6 below on bilateral arrangements owing to increased generation but the low levels in the power trade are still an indication of inadequate interconnection among countries.

Country	Net imports in 2010 (GWh)	Net imports in 2013 (GWh)
Burundi	84	92
DRC	-755	-8
Djibouti	0	0
Egypt	-1,595	-390
Ethiopia	0	-384
Kenya	11	11
Libya	-82	46
Rwanda	59	90
Sudan	0	0
Tanzania	57	60
Uganda	-46	58

Source: AFREC, 2015

Table 6: Imports and Exports

2.7.6 Electrification rates

Access to electricity in most EAPP countries is still low with notable differences between countries as related to the GDP Table 1 and availability Table 2 though improvements have been registered during the period as shown in Table 7. These improvements reflect the increased commitment by member countries to comply with global initiatives like SE4ALL that target universal access to modern energy access by 2030 through multi-pronged approaches ranging from grid extension, micro-grids and solar home systems.

Country	National rate in 2008 (%)	National rate in 2013 (%)	Urban rate in 2013 (%)	Rural rate in 2013 (%)
Burundi	2.3	5	28	2
DRC	6	9	19	2
Djibouti	44	50	61	14
Egypt	99	100	100	99
Ethiopia	41	24	85	10
Kenya	20	20	60	7
Libya	100	100	100	99
Rwanda	4	21	67	5
Sudan	30	35	63	21
Tanzania	14	24	71	4
Uganda	10	15	55	7

Source: IEA, 2016

Table 7: Electrification rates

2.7.7 Development projects

A number of projects are underway in the region supported through various implementation arrangements aimed at facilitating power trade and operation of the Power Pool; details are attached in Appendix 1.

2.7.8 Challenges

EAPP faces a number of challenges that include:

1. Lack of adequate capacity but a number of countries that include Rwanda, Tanzania, Kenya, Uganda and Ethiopia are pursuing several development projects to address this;
2. Limited power trade among countries due to a lack of interconnections, however a number of priority projects are being carried out (section 1.7.8) to address this matter;
3. Weak alignment of national development plans with the regional Master Plan; this will be addressed with time as the Power Pool gains more ground;
4. Weak incentives for private sector participation; a number of countries have enacted enabling legislation to enhance Public-Private- Partnerships; and
5. Inadequate reliable data; a key input in planning but with continued development and more resources, this matter will also be addressed.

2.7.9 Trends

Demand is projected to increase by a factor of 3.5 by 2030, based on the EAPP/EAC Master Plan, boosting regional demand to around 500 TWh by 2030, with Egypt accounting for almost 75% of the total, at more than 370 TWh. In contrast, five smaller countries (including Burundi and Rwanda) would together account for less than 2% of the total. Demand from industrial users would account for the largest share by 2030, at 44%, with urban and rural demand at 39% and 17% respectively. The total investment needs would amount to almost US$ 400 billion (undiscounted), of which more than 40% would go to country-level transmission and distribution networks.

Chapter 3
West African Power Pool (WAPP)

Box 2: WAPP trends

The West African Power Pool was established by the Summit of the Economic Community for West African States in 2000 to promote reliable power supply in a region that is characterised by lower levels of connections and power trade among states - despite widespread and diverse energy assets that include crude oil, natural gas and hydropower.

Commendable efforts are underway to deal with this power problem and member countries seem committed to the regional approach through WAPP to convert these resources into power production, with the ensuing revenue used for public benefits. This still faces a number of challenges:

1. Limited power trade among countries due to a lack of interconnections;
2. Weak alignment of national development plans with the Regional Master Plan;
3. Weak incentives for private sector participation;
4. High tariffs; and
5. Lack of adequate reliable data.

The demand is projected to increase fivefold by 2030, to 250 TWh, based on the ECOWAS Master Plan with an overall investment need amounting to US$ 170 billion. This will cover domestic transmission and distribution (T&D) costs and cross-border transmission line costs.

3.1 Introduction

The West African Power Pool (WAPP) was created by Decision A/DEC.5/12/99 of the 22nd Summit of the Authority of the Economic Community for West African States (ECOWAS) Heads of State and Government with the aim of promoting reliable power supply in the West African sub-region. Subsequently in January 2006, through Decisions A/DEC.18/01/06 and A/DEC.20/01/06, the 29th Summit of the Authority of ECOWAS Heads of State and Government held in Niamey respectively adopted the Articles of Agreement for the establishment and functioning of WAPP, and granted the WAPP Secretariat status of a specialised institution of ECOWAS.

2.2 Vision

To integrate the operations of the national power systems into a unified regional electricity market, which will, over the medium to long term, assure the citizens of ECOWAS Member States stable and reliable electricity supply at a competitive cost.

3.3 Objectives

WAPP's key objectives are to:

- Increase investments needed for power grid expansion in the region, with emphasis on the implementation of cross-border projects that will enhance supply and reliability, and reduce costs to end users;

- Create an attractive environment for investment in order to facilitate the funding of power generation and transmission facilities, including creating a common operating standard, rules and a transparent and reliable mechanism for the swift settlement of power trade transactions; and

- Formalise official and extended collaboration in the region to expand power generation,

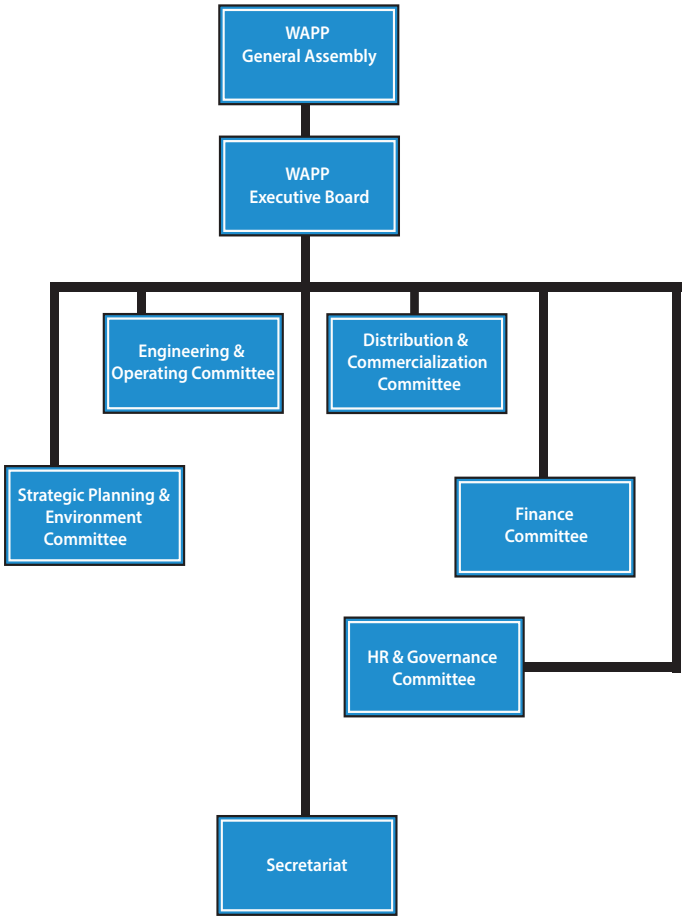
transmission and trade.

3.4 Membership

The present membership consists of the following 14 countries: Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.

3.5 Governance structure

WAPP has four (4) governing bodies: the General Assembly, the Executive Board, the Organisational Committees and the General Secretariat; as illustrated in the Figure 2 below:



Source: Ki, 2016

Figure 2: WAPP Organisation structure

3.6 Socio-economic background

The GDP of the countries in the region is as shown in the Table 8, with Nigeria well above the rest other members of the community; and as expected this is positively correlated with the consumption Table 11 and electrification rates Table 14:

	Year 2008		Year 2015	
Country	GDP ($Bn)	Pop. (Mn)	GDP ($Bn)	Pop. (Mn)
Benin	7	9.3	8	10.6
Burkina Faso	9	15.2	11	18.5
Côte d'Ivoire	25	20.7	32	23.3
Gambia	1	1.6	1	2
Ghana	32	23.9	38	27.7
Guinea	5	10.3	7	11
Guinea Bissau	1	1.7	1	1.8
Liberia	1	3.9	2	4.5
Mali	11	12.7	13	16.7
Niger	6	14.7	7	18.7
Nigeria	369	148.1	481	181.8
Senegal	12	12.7	14	14.7
Sierra Leone	3	5.5	4	6.5
Togo	3	6.8	4	7.2

Source: World Bank database, 2013; PRB 2008, 2015

Table 8: Socio-economic data of WAPP member countries

3.7 Overview of the energy sector

3.7.1 Installed capacity

Based on information obtained, the total installed capacity has increased by about 34%; and this increment is due to a number of factors that include the increased demand due to GDP growth Table 8, increased power trade Table 13 and access rates Table 12 supported by global initiatives like SE4ALL aiming at attaining universal access to modern energy by 2030.

Country	2008 (MW)	2015 (MW)
Benin	145	208
Burkina Faso	252	265
Côte d'Ivoire	1,541	1,772
Gambia	53	102
Ghana	2,216	3,139
Guinea	440	578
Guinea Bissau	27	21
Liberia	78	91
Mali	468	241
Niger	134	130
Nigeria	8,469	12,140
Senegal	639	634
Sierra Leone	77	100
Togo	130	227
Total	**14,669**	**19,648**

Source: Primary data from WAPP, 2016

Table 9: Installed capacity

3.7.2 Production

With the increased installed capacity Table 9 production has also grown as shown in Table 10 to meet the increased demand; and reasons are similar to those of EAPP.

3.7.3 Consumption

In line with the increased GDP Table 8 and access Table 14 and 15; the consumption in member countries has changed over the period as shown in the Table 11. This has been due to the commitment by ECOWAS members towards enhancing regional power trade.

Country	2010 (GWh)	2015 (GWh)
Benin	152	162
Burkina Faso	565	731
Côte d'Ivoire	5,888	9,103
Gambia	250	238
Ghana	10,166	12,871
Guinea	615	1,182
Guinea Bissau	-	75
Liberia	-	40
Mali	627	2,635
Niger	268	452
Nigeria	25,045	25,201
Senegal	2,246	3,710
Sierra Leone	-	332
Togo	132	208
Total	**45,954**	**56,940**

Source: Primary data from WAPP, 2016

Table 10: Generation in WAPP

Country	2010	2015 (GWh)
Benin	2,015	162
Burkina Faso	950	731
Côte d'Ivoire	5,548	9,103
Gambia	250	238
Ghana	8,811	12,871
Guinea	615	1,182
Guinea Bissau	-	75
Liberia	-	40
Mali	1,207	2,635
Niger	818	452
Nigeria	23,722	25,201
Senegal	2,500	3,710
Sierra Leone	-	332
Togo	500	208
Total	**46,936**	**56,940**

Source: Primary data from WAPP, 2016

Table 11: Consumption (GWh)

3.7.4 Consumption per capita

In line with the GDP growth Table 8 and supported by the availability of more capacity

Table 10; correspondingly the consumption per capita also increased – Table 12; the drop in Nigeria is partly due to lack of adequate capacity.

Country	2010	2015
Benin	217	219
Burkina Faso	59	147
Côte d'ivoire	252	239
G Bissau	-	44
Gambia	139	126
Ghana	284	358
Guinea	57	94
Liberia	-	9
Mali	79	168
Niger	51	44
Nigeria	150	135
S Leone	-	51
Senegal	200	228
Togo	74	162

Source: Primary data from WAPP and PRB, 2014

Table 12: Consumption per capita (KWh)

3.7.5 Imports and Exports

Power imports and exports among the various countries have changed over the period as tabulated below in the Table 13 on account of increased interconnection and cooperation among countries.

Country	2010	2015
Benin	935	987
Burkina Faso	385	523
Côte d'Ivoire	-471	-551
Ghana	-930	-519
Guinea	-	-
Guinea Bissau	-	-
Mali	0	13
Niger	653	643
Nigeria	0	0
Senegal	253	284
Sierra Leone	-	-
Togo	706	659

Source: AFREC, 2015

Table 13: Net imports and exports (GWh)

3.7.6 Electrification rates

There have been dramatic changes in electrification rates particularly in Ghana, while the declines in Ivory Coast and Sierra Leone are attributed to political upheavals, as shown in the Table 14. Based on information obtained from WAPP; there are many initiatives in the Region aimed at increasing capacity enhancement, regional interconnections and access to modern energy and these are expected to result into dramatic upturn.

Country	2008	2015
Benin	23	29
Burkina Faso	10	17
Côte d'Ivoire	30	26
Gambia	25	36
Ghana	25	72
Guinea	13	26
Guinea Bissau	3	21
Mali	10	26
Niger	3	15
Nigeria	40	45
Senegal	30	55
Sierra Leone	8	5
Togo	13	27

Source: Primary data from WAPP, 2016

Table 14: Aggregated electrification national rates (%)

Further analysis shows the divide between electrification rates in urban and rural areas are found to be very pronounced across countries in the region, see Table 15 below. Like other countries in other regions. Countries in the community are pursuing a number of initiatives with international support to address this matter.

3.7.7 Development projects

In 2011, WAPP had an ambitious programme of proposed investments, premised on the following priority projects that will not only enhance regional power trade but will also boost the demand and access resulting into increased GDP growth.

Country	National	Urban	Rural
Benin	29	57	9
Burkina Faso	17	56	1
Côte d'Ivoire	26	42	8
Gambia	36	60	2
Ghana	72	92	50
Guinea	26	53	11
Guinea-Bissau	21	37	6
Liberia	10	17	3
Mali	26	53	9
Niger	15	62	4
Nigeria	45	55	37
Senegal	55	90	28
Sierra Leone	5	11	1
Togo	27	35	21

Source: Primary data from WAPP

Table 15: Electrification (%) rates - 2015

The Project include:

- Coastal Transmission Backbone Sub-programme (Côte d'Ivoire, Ghana, Benin/ Togo, Nigeria);
- Inter-zonal Transmission Hub Sub-programme (Burkina Faso, OMVS via Mali, Mali via Côte d'Ivoire, Liberia / Sierra Leone / Guinea via Côte d'Ivoire);
- North-core Transmission Subprogram (Nigeria, Niger, Burkina Faso, Benin);
- OMVG/OMVS Power System Development Sub-programme (The Gambia, Guinea, Guinea Bissau, Mali, Senegal);
- Côte d'Ivoire-Liberia-Sierra Leone-Guinea Power System Re-development Sub-programme (Côte d'Ivoire, Liberia, Sierra Leone, Guinea); and
- WAPP Strategic Generation Sub-programme (Emergency Power Supply Security Plan).

Based on data obtained from the WAPP, the status of the priority projects is as indicated in Appendix 2.

3.7.8 Challenges ahead

WAPP has to overcome a number of challenges, including:

- Demand continues to outgrow production capacity implying load shedding is becoming more prominent;
- The energy crisis in the sub-region has led to ECOWAS Member states adopting non-optimal solutions that have deviated from the ECOWAS vision for an integrated, sustainable and vibrant electricity market in West Africa; and
- Institutional frameworks of national electricity sub-sectors and the technical, financial and operational performances of utilities need to strengthened.

3.7.9 Trends

The demand is projected to increase fivefold by 2030, to 250 TWh, based on the ECOWAS Master Plan. Currently 87% of demand comes from urban users, with almost all of the rest from industry. Rural demand is currently insignificant but this mix is projected to change by 2030, with urban demand dropping to 48%, industrial demand rising to 45% and rural demand climbing to 7%. The overall investment needs in the region during this period amount to US$ 170 billion, with domestic transmission and distribution (T&D) costs and cross-border transmission lines comprising about 37% of the total.

Chapter 4
Southern African Power Pool (SAPP)

Box 3: SAPP trends

The Southern African Power Pool was established under the Southern African Development Community (SADC) in 1995 to promote energy development as part of the political goal of regional integration. Presently, SAPP is the only regional power market in Africa with a competitive energy market in the form of a Day-Ahead Market (DAM) that was established in 2009. In 2015, the SAPP started upgrading the market trading platform in preparation for the intra-day market and forward physical markets.

SAPP has two main challenges, related to limited generation and transmission capacity and power shortages. Regional demand is projected to almost double by 2030, from the current level of 280 TWh to 570 TWh with South Africa's share of demand projected to drop from 82% to 72% by 2030 because of its mature economy and therefore faster growth rates in the rest of the region. The overall investment needs in the region during this period amount to more than US$ 270 billion; this includes domestic T&D costs and cross-border transmission lines that would account for nearly half of total investment costs.

4.1 Introduction

The Southern African Power Pool (SAPP) is the first formal international power pool in Africa and is currently the most advanced in the region. The SAPP was a product of efforts aimed at promoting energy development undertaken as part of the political goal of regional integration of the Southern African Development Community (SADC) established in 1992, with the primary aim of providing reliable and economic electricity supply to the consumers of each of the SAPP members, consistent with the reasonable utilisation of natural resources and the effect on the environment. One of the major political and economic forces behind the development of SAPP has been South Africa's yearning to meet future energy demand by importing low-cost hydropower from its northern neighbours.

4.2 Vision

The Vision of SAPP is to:

- Facilitate the development of a competitive electricity market in the Southern African region;
- Give the end user a choice of electricity supply;
- Ensure that the Southern African region is the region of choice for investments by energy-intensive users; and
- Ensure sustainable energy developments through sound economic, environmental and social practices.

4.3 Objectives

The objectives of the SAPP are to:

- Co-ordinate and co-operate in the planning and operation of electricity power systems to minimise costs, while maintaining reliability, autonomy and self-sufficiency;
- Increase interconnectivity between SADC countries so as to increase the reliability of power supplies;
- Harmonise relationships between member utilities so as to facilitate cross-border electricity trading;
- Provide a forum for the development of a

world-class, robust, safe, efficient, reliable and stable interconnected electrical system in the Southern African region;

- Co-ordinate and enforce common regional standards of quality of supply, measurement and monitoring of systems performance;
- Facilitate the development of regional expertise through training programmes and research;
- Increase power accessibility in rural communities;
- Implement strategies in support of sustainable development priorities; and
- Recover costs of operations and equitably share benefits, including reductions in generating capacity and fuel costs, and improving use of hydroelectric energy.

4.4 Membership

SAPP membership is made up of the following countries Angola, Botswana, DRC, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

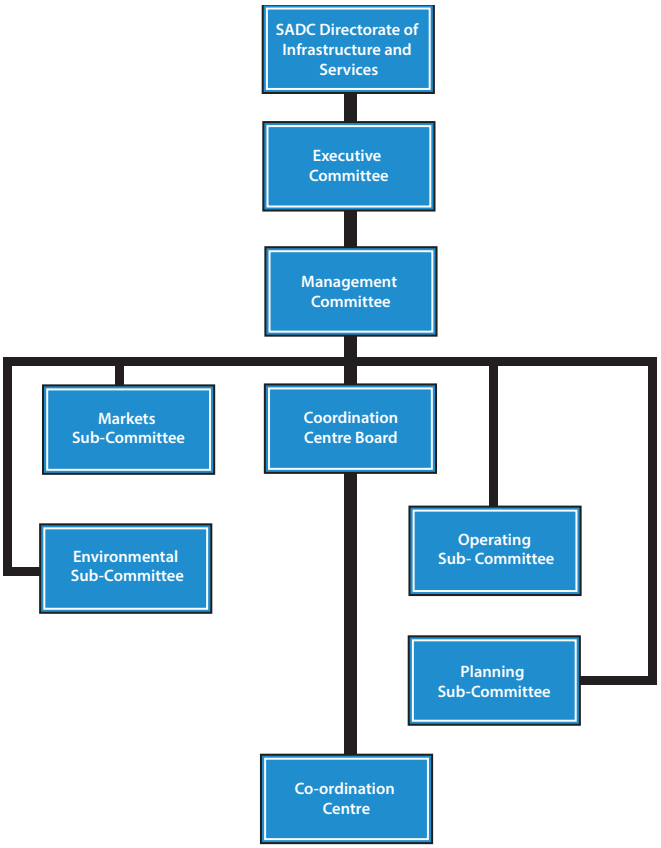
4.5 Governance

The SAPP is governed by the following instruments:

- The Inter-Governmental Memorandum of Understanding;
- The Inter-Utility Memorandum of Understanding;
- Agreement between operating members; and
- Operating guidelines.

4.6 Socio-economic background

South Africa is the most dominant economic giant in the region as illustrated in Table 16 below and this tally with the energy consumption as shown in the Table 19.



Source: SAPP Annual Report, 2015

Figure 3: SAPP Management Structure

Country	Year 2010		Year 2015	
	GDP	Popula-tion	GDP	Popula-tion
Angola	85	19	103	25
Botswa-na	13	1.8	14	2.1
DRC	21	67.8	35	73.3
Lesotho	2	1.9	2	1.9
Malawi	7	15.4	7	17.2
Mozam-bique	10	23.4	15	25.7
Namibia	11	2.2	12	2.5
South Africa	375	49.9	313	55
Swazi-land	4	1.2	4	1.3
Tanzania	31	45	45	52.3
Zambia	20	13.3	21	15.5
Zimba-bwe	9	12.6	14	17.4

Source: The World Bank, 2015; www.prb.org 2010, 2015

Table 16: Socio – economic data of SAPP member countries

4.7 Overview of the energy sector

4.7.1 Installed capacity

In 2001 total installed capacity stood at 56,000MW with South Africa contributing about 78.2%; this has now increased to 61,859MW with 52,589MW available; see Table 17 below; though it is not adequate to meet the demand.

Country	2010	2015
Angola	1,155	2,210
Botswana	152	892
DRC	2,476	2,442
Lesotho	80	74
Malawi	502	352
Mozam-bique	2,428	2,724
Namibia	467	501
South Africa	43,738	46,963
Swaziland	70	70
Tanzania	1,008	1,380
Zambia	1,770	2,206
Zimbabwe	2,102	2,045
Total	55,948	61,859

Source: SAPP Annual Report, 2016

Table 17: Installed capacity (MW)

4.7.2 Production

There has been a modest increment in the production of the countries, from about 270,000 GWh to about 277,000GWh over the period 2008 to 2015, as shown in the Table 18, partly due to more efficient usage through aggressive demand side management techniques deployed and shortage of capacity attributed to the severe drought.

4.7.3 Consumption

Power consumption by SAPP member countries has grown from 260,081GWh in 2010 (with South Africa alone representing an average of 84% of total consumption) to 269,375GWh in 2015. Notwithstanding this there have been modest increments in other countries, as show in Table 19. The consumption would have been much higher if demand side management techniques had not been deployed owing to shortage of available capacity.

Country	2008	2015
Angola	4,900	5,613
Botswana	445	372
DRC	7,641	8,185
Lesotho	486	486
Malawi	1,543	1,809
Mozambique	341	390
Namibia	1,305	1,305
South Africa	232,812	237,430
Swaziland	288	288
Tanzania	4,371	3,034
Zambia	10,156	11,381
Zimbabwe	6,951	6,951
Total	**271,239**	**277,244**

Source: SAPP Annual Report, 2016

Table 18: Generation (GWh)

Country	2010	2015
Angola	3,498	3,427
Botswana	2,936	3,118
DRC	6,323	7,548
Lesotho	488	488
Malawi	1,439	1,476
Mozambique	1,748	2,380
Namibia	3,648	3,648
South Africa	218,591	224,446
Swaziland	1,019	1,019
Tanzania	3,393	3,770
Zambia	9,631	10,688
Zimbabwe	7,367	7,367
Total	**260,081**	**269,375**

Source: SAPP Annual Report, 2016

Table 19: Consumption (GWh)

4.7.4 Consumption per Capita

The consumption per capita like in other regions is positively correlated with the GDP; with South Africa as expected far ahead; see Table 20.

Country	2010	2015
Angola	184	137
Botswana	1,631	1,485
DRC	93	103
Lesotho	257	257
Malawi	93	86
Mozambique	75	93
Namibia	1,658	1,459
South Africa	4,377	4,044
Swazi	849	784
Tanzania	75	72
Zambia	724	690
Zimbabwe	585	423

Source: SAPP Annual Report, 2016

Table 20: Consumption per Capita (kWh)

4.7.5 Imports and Exports

Imports and exports in the region have dramatically changed, reflecting the enhanced power trade due to increased interconnection and generation capacity, see in the Table 21 below.

Country	2010	2015
Angola	0	0
Botswana	2,985	3,534
DRC	-755	0
Lesotho	121	223
Malawi	0	0
Mozam-bique	-3,542	-1,593
Namibia	2,255	2,383
South Africa	-2,475	-5,313
Swaziland	909	479
Tanzania	57	60
Zambia	-545	-563
Zimbabwe	63	46

Source: AFREC, 2015

Table 21: Net imports and exports (GWh)

4.7.6 Electrification rates

The countries that have made substantial improvements in electricity access over the period include Botswana from 22% to 66%, Mozambique from 11% to 39%, Tanzania from 10% to 24% and South Africa from 75% to 85%. Other countries have made minimal gains; see in the Table 22 below:

Country	Average rates in 2008 %	Average rates in 2015 %
Angola	15	30
Botswana	22	66
DRC	8	9
Lesotho	8	17
Malawi	9	9
Mozambique	11	39
Namibia	31	32
South Africa	75	85
Swaziland	28	28
Tanzania	10	24
Zambia	29	29
Zimbabwe	40	40

Source: SAPP, IEA; 2015

Table 22: Electrification rates (%)

4.7.7 Development projects

The status of the priority projects at regional level is shown in Appendix 3; these will not only facilitate the import of power that is in high demand especially in South Africa but will advance Africa's integration through links to EAPP and CAPP.

4.7.8 Challenges

The main challenge that faces the Region is lack of capacity to meet the demand that worsened recently due to the drought in 2015 that severely affected countries that have a high dependency on hydro generation. A number of strategies have been devised to mitigate this shortfall that include demand side techniques like phasing out incandescent bulbs.

4.7.9 Trend forward

Regional demand is projected to almost double by 2030, from a current level of 280 TWh to 570 TWh with South Africa's share of demand likely to drop from 82% to 72% by 2030 because

of its mature economy and therefore faster growth rates in the rest of the region. Industrial demand is projected to decrease from the current level of 66% to 57%, whereas urban demand is seen rising from 32% to 38%, while rural demand is projected to move from 2% to 4%. Overall investment needs in the region during this period amount to more than US$ 270 billion; this includes domestic T&D costs and cross-border transmission lines that would account for nearly half of total investment.

In the meantime, given developments in generation and transmission interconnections taking place in the region, it is expected that more member counties will be operational members by the end of 2018. There is also a planned interconnection between EAPP and SAPP.

Chapter 5
Central African Power Pool (CAPP) / Pool Energé que de l'Afrique Centrale (PEAC)

Box 3: CAPP trends

The Central African Power Pool (CAPP); a specialised agency of the Economic Community for Central African States (ECCAS) was established in 2003 to promote power development in the region, which is dominated by isolated national networks despite the enormous hydro potential.

CAPP has the following main challenges:

1. Limited power trade among countries due to lack of interconnections;
2. Weak incentives for private sector participation; and
3. Lack of adequate reliable data.

Electricity demand is expected to increase to about 90 TWh in 2030 with a total investment requirement of more than US$ 60 billion (undiscounted), of which one third would go to T&D. About US$ 3 billion in revenues would come from exports to the WAPP and SAPP regions from 2023, assuming the Grand Inga project proceeds as planned.

5.1 Introduction

The Central African Power Pool (CAPP) was created on 12 April 2003 as a specialised agency of the Economic Community for Central African States (ECCAS) through the:

- Inter-Governmental MOU signed by ministers responsible for electricity in ECCAS; and
- Inter-utility MOU signed by CEOs of the national utilities; both were signed in April 2003.

5.2 Mission

The mission of PEAC is:

To contribute to the establishment of a regional electricity market to meet the electricity needs of its industries and populations, while ensuring a reliable supply of cheap electricity, in support of economic and social development and respect for the environment.

5.3 Objectives

The objectives include:

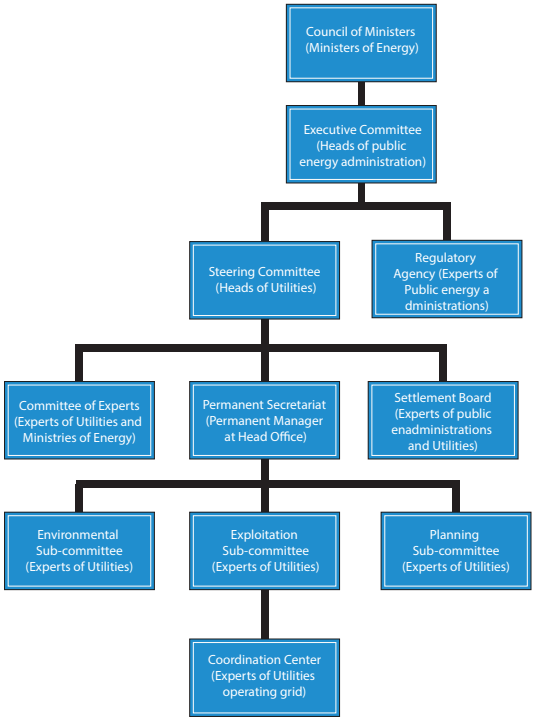
- Increasing the reliability of electricity supply in different ECCAS countries;
- Expanding the population's access to electricity and reducing poverty;
- Improving the electricity system's performance and quality of supply in the region;
- Creating a regional forum for discussion of energy sector problems and searching for appropriate solutions within the framework of the defined policies and with due attention to the environmental impacts and;
- Establishing a liberalised energy market place.

5.4 Membership

Countries include: Angola, Burundi, Cameroon, Central Africa Republic, Chad, Congo, DRC, Equatorial Guinea, Gabon, Sao Tome and Principe.

5.5 Governance

The present institutional framework was established by the two MOUs signed in 2003 that led to the establishment of the offices in Brazzaville, Congo; as illustrated in the Figure 7 below.



Source: PEAC, 2016

Figure 4: CAPP management structure

5.6 Socio-economic background

Angola stands out economically as the strongest country in the region, while DRC and Cameroon come second and third respectively. Chad, Congo, Gabon and Guinea the follows in that order; see in the Table 23 below; however the over reliance on oil exports makes these countries very vulnerable, as evidenced by the impact during the last oil crisis.

Country	Year 2010		Year 2013	
	GDP ($Bn)	Popu-lation	GDP ($Bn)	Popu-lation
Angola	85	19	103	21.6
Burundi	2	8.5	3	10.9
Cameroon	24	20	29	21.5
CAR	2	4.8	2	4.7
Chad	11	11.5	11	12.2
Congo	12	3.9	9	4.4
DRC	21	67.8	35	71.1
Eq. Guinea	13	0.7	9	0.8
Gabon	14	1.5	14	1.6
Sao Tome	0	0.2	0	0.2

Source: The World Bank, 2015; PRB, 2013

Table 23: Socio-economic data of CAPP member countries

5.7 Overview of the energy sector

5.7.1 Installed capacity

The installed capacity in this Region is very low compared with the huge potential that exists and consists of mainly national isolated systems; this pattern is changing with the increased appreciation of regional power trade opportunities and the increased investments in the Region; see Table 24.

Country	2008	2013
Angola	1,155	1,530
Burundi	33	42
Cameroon	937	1,049
CAR	44	44
Chad	41	41
Congo	238	400
DRC	2,476	2,506
Equatorial Guinea	41	41
Gabon	366	627
Sao Tome	14	19
Total	**5,345**	**6,299**

*Source: http://www.un.data.org ; 2014

Table 24: Installed capacity (MW)

5.7.2 Production

Total generation in the CAPP in 2010 (excluding self-generation, which represent a significant share of thermal power plants in countries like Cameroon, Chad and DRC) was 22,499GWh has grown to 25,842GWh in 2013 – details are in the Table 25:

5.7.3 Power consumption (GWh)

In 2010, power consumption by CAPP member countries was estimated at 19,669 GWh as compared to 24,744GWh in 2013 as tabulated in Table 26 below; this also correlates with the GDP like in other areas:

Country	2010	2013
Angola	5,448	6,370
Burundi	241	184
Cameroon	5,958	6,523
CAR	160	144
Chad	100	269
Congo	781	1,407
DRC	7,600	8,391
Equatorial Guinea	410	413
Gabon	1,776	2,113
Sao Tome	25	28
Total	**22,499**	**25,842**

Source: AFREC, 2015

Table 25: Generation in CAPP (GWh)

Country	2010	2013
Angola	4822	6,236
Burundi	221	271
Cameroon	5319	6,119
CAR	149	105
Chad	91	236
Congo	600	1,488
DRC	6,757	7,876
Equatorial Guinea	90	421
Gabon	1592	1,966
Sao Tome	28	26
Total	**19,669**	**24,744**

Source: AFREC, 2015

Table 26: Consumption (GWh)

5.7.4 Consumption per capita

According to the ICA's 2011 Report, wide disparities existed among the countries regarding electricity consumption per capita; varying from 1,326kWh in Gabon, to 532kWh in Equatorial Guinea and down to 9kWh in Chad. In 2013, the wide disparities still exist but there have been very slight changes in the quantities, as shown in Table 27 below:

5.7.5 Imports and exports

According to the ICA's 2011 Report, in 2008 exports from DRC had reached 1,230GWh,

Country	2010	2013
Angola	196	289
Burundi	24	25
Cameroon	204	285
CAR	15	22
Chad	13	19
Congo	72	338
DRC	72	111
Equatorial Guinea	314	526
Gabon	957	1,229
Sao Tome & Principe	110	130

Source: AFREC, 2015; PRB, 2013

Table 27: Consumption per capita (kWh)

as compared to 660 GWh imported during the same year, and a limited regional power trade was taking place among a few countries through interconnections between:

- DRC and Congo (60MW capacity);
- DRC and Zambia to SAPP (150MW capacity); and
- DRC to Burundi, CAR, Rwanda and Angola with medium-voltage cross-borders sales.

It was further reported that the commissioning of the Imboulou hydropower plant in Congo had substantially decreased its imports from DRC. According to AFREC, in 2015 the net importers in the region were Burundi (92GWh), Congo (37GWh) and DRC with a net export of 8GWh in 2013.

Country	2010	2013
Angolaw	0	0
Burundi	84	92
Cameroon	0	0
CAR	0	0
Chad	0	0
Congo	281	37
DRC	-755	-8
Equatorial Guinea	0	0
Gabon	0	0
Sao Tome & Principe	0	0

Source: AFREC, 2015

Table 28: Net imports and export (GWh)

5.7.6 Electrification access

There have been some improvements in the connection rates especially in Gabon and Cameroon; details are as shown in the Table 29 below.

Country	National 2009	National 2013	Urban 2013	Rural 2013
Angola	26	30	30	18
Burundi	2	5	5	2
Cameroon	28	55	55	17
CAR	2	3	3	1
Chad	4	4	4	1
Congo	29	42	42	5
DRC	8	9	9	2
Eq. Guinea	28	66	66	48
Gabon	38	89	89	38
Sao Tome	49	59	59	40

Source: IEA, 2015

Table 29: Electrification rates (%) in CAPP

5.7.7 Priority projects

A number of priority projects identified in the ICA's 2011 Report aimed at boosting the region's generation capacity and interconnections are still at the feasibility stage. The status in 2015 is as provided in Appendix 4.

5.7.8 Challenges

The main challenge that faces the Region is the low interconnection amongst member countries; the present national isolated systems cannot raise enough resources or demand to make the development of the big projects viable. It is hoped that CAPP will be facilitated to play its pivotal role and guide the regional developments.

5.7.9 Trends

Electricity demand is expected to increase to about 90TWh in 2030; with urban, industrial and rural demand projected to account for 57%, 39% and 4% respectively. The total investment amount required is in excess of US$ 60 billion (undiscounted), of which one third would go to T&D. About US$ 3 billion in revenues would come from exports to WAPP and SAPP from 2023, assuming the Grand Inga project proceeds as planned.

Chapter 6
COMITÉ MAGHRÉBIN DE L'ELECTRICITÉ (COMELEC)

Box 5: COMELEC trends

The Maghreb Electricity Committee (COMELEC) was established as a specialised agency for the Union of Maghreb area (UMA) in 1989; a 5-country member body of Algeria, Libya, Mauritania, Morocco and Tunisia.

The region, which is highly reliant on thermal generation, has the highest connectivity and the best infrastructure in Africa. It is also linked to the Middle East via the Egypt-Jordan interconnector and to Europe via the Morocco-Spain line (part of the future Mediterranean Electricity Ring, MEDRING). Very limited power trade levels amongst member countries characterise the region. Primarily, this could be attributed to obstacles such as limited generation reserve margins, the absence of a harmonised regulatory framework with clear rules governing electricity trade, and institutional weaknesses at regional level.

In future it is expected that the desire to improve supply security through the diversification of energy supply resources, particularly in the context of the inter-regional programmes for the development of renewable (wind and solar) resources, will enhance regional power trade. Overall power demand is expected to increase to about 980TWh by 2030.

6.1 Introduction

The Maghreb Electricity Committee (Comité Maghrébin de L'Electricité - COMELEC) was adopted by the Union of Maghreb Arab (UMA) – a Regional Economic Community (REC) covering five Northern Africa countries (Algeria, Libya, Mauritania, Morocco and Tunisia) established in 1987 - as its specialised agency in 1989.

6.2 Vision

To study and propose solutions to power utilities companies that are members, and share best practice.

6.3 Objectives

COMELEC's has as main objective is to study issues faced by member utilities and to share best practice through the following action:

- Promote regular exchange of information among member utilities;
- Coordinate generation and transmission investment programmes as well as capacity building activities;
- Follow-up on interconnection developments and related issues; and
- Promote power industry integration in the Maghreb region.

6.4 Membership

In 1972, three North Africa Utilities, the Office National de l'Electricité of Morocco (ONE), the Société Nationale de l'Electricité et du Gaz of Algeria (SONELGAZ) and the Société Tunisienne de l'Electricité et du Gaz of Tunisia (STEG) decided to create the Comité Maghrébin de l'Electricité (COMELEC). Two other utilities joined COMELEC later: SOMELEC of Mauritania and GECOL of Libya.

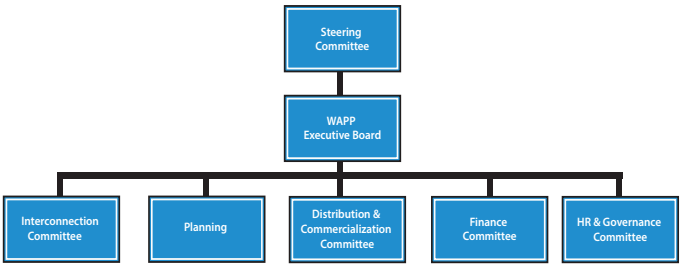
6.5 Governance

COMELEC consists of two bodies namely:

- A Steering Committee as a deliberative body, which defines the strategic development of COMELEC and ensures implementation. Its resolutions are taken unanimously and take

into consideration existing international standards; and a

- General Secretariat provided by the Headquarters of COMELEC (in Algiers) that prepares the work of the Committee, disseminates its decisions and recommendations, represents COMELEC in international organisations and ensures the implementation of the work programmes. The General Secretariat also organises the ordinary and extraordinary sessions of the Committee



Source: COMELEC, 2003

Figure 5: Organisation structure for COMELEC

in liaison with the host organisations.

COMELEC relies on six committees, namely:

- Maghreb Interconnection Commission (CIM) is the operational organisation of COMELEC and supervises the operation of the Maghreb interconnections. It ensures the mastery of the interactions of the Maghreb electrical system with the other networks. The CIM is the representative of COMELEC vis-à-vis other organizations on all technical issues relating to electrical interconnections;
- Commission for Planning and Studies (CPE), which is responsible for the interconnection study, the establishment of a framework for the coherence of the master plans for the development of the Maghreb networks, and the establishment of a system of tariffs;
- Technical Commission (CT), which is responsible for the electrification of the border villages, studying the possibility for reducing costs of the structures and the study of normalisation and integration in the Maghreb;
- The Commission for Management and Human Resources (HRM) is responsible for carrying out actions to promote exchanges of experts and experiences, particularly by encouraging training;
- The Commission for New and Renewable Energies (CENR) (without nuclear power) of the COMELEC; it constitutes opening the organisation to new technologies and to unconventional electricity generation. It aims to master these technologies in order to integrate them into the electrical system in the best techno/economic conditions; and finally
- The COMELEC Trade Commission (CC), which was created by decision of the Steering Committee, at its meeting in Tripoli on 09 December 2009.

6.6 Socio-economic background

The countries have registered growth in their GDP except Libya that had a fall due to the political strife, as indicated in the Table 29 below:

	Year 2010		Year 2013	
	GDP - $Bn	Pop. (106)	GDP -$Bn	Pop. (106)
Algeria	161	36	167	38.3
Egypt	219	80.4	331	84.7
Libya	75	6.5	29	6.5
Mauritania	4	3.4	5	3.7
Morocco	93	31.9	100	33
Tunisia	44	10.5	43	10.9

Source: World Bank, 2015

Table 30: Socio-economic data of COMELEC member countries

6.7 Overview of the energy sector

6.7.1 Installed capacity

The installed generation capacity in the

countries has increased by about 50% over the period, as shown in the Table 30 below; this was as a result of increased demand in the Region:

Country	2008	2013
Algeria	8,041	15,097
Libya	6,612	9,455
Mauritania	156	263
Morocco	5,564	7,013
Tunisia	3,654	4,539
Total	**24,027**	**36,367**

Source: AFREC, 2013

Table 31: Installed capacity (MW)

6.7.2 Production

The total production in the region has changed as illustrated in the Table 32 below, but there is still a challenge of un-met increasing demand.

Country	2008	2013
Algeria	43,005	56,149
Libya	30,426	31,183
Mauritania	476	506
Morocco	20,267	26,779
Tunisia	14,962	18,369
Total	**109,136**	**132,986**

Source: AFREC, 2013

Table 32: Generation (GWh)

6.7.3 Power consumption

The growing power consumption in the countries especially Morocco as shown in the Table 33 is posing a serious challenge to the other countries.

Country	2009	2013
Algeria	33,817	43,156
Libya	20,336	31,183
Mauritania	347	506
Morocco	22,384	30,628
Tunisia	12,214	14,727
Total	**89,098**	**120,200**

Source: AFREC, 2013

Table 33: Consumption in COMELEC (GWh)

6.7.4 Consumption per capita

There has been increase in consumption per capita in all COMELEC countries except Mauritania, where it has remained unchanged over the period, as shown in the Table 34 below:

Country	2008	2013	% Change
Algeria	976	1,127	15
Morocco	710	926	30
Tunisia	1,274	1,351	8
Mauritania	108	108	0
Libya	3,384	4,815	42

Source: AFREC, 2015; PRB, 2013

Table 34: Consumption per capita (kWh)

6.7.5 Imports and exports

All COMELEC countries except Mauritania are connected to a regional electricity network in the Maghreb region and there are presently: (i) 400 kV connections between Spain, Morocco, Algeria and Tunisia, and (ii) 220 kV connections between Algeria-Tunisia-Libya and Egypt. These interconnections among Maghreb countries have provided substantial technical and economic gains, such as mutual and instantaneous back-up to national grids when needed and a reduction in reserve margins. Although a number of interconnections are running in the region, the actual level of power exchange is often far below the nominal value. Except for power exports from Spain to Morocco, regional power trade between Algeria-Morocco and Algeria-Tunisia are on average only 5%-16% of interconnection capacities.

Country	2010	2015
Algeria	83	-
Libya	-	-
Mauritania	-	44.3
Morocco	251	814
Tunisia	-	-

Source: AFREC, 2013

Table 35: Imports and exports (GWh)

6.7.6 Electrification rates

Essentially, this is a saturated market except for Mauritania and, according to 2013 data, electrification is nearly 100% in the rest of the countries; see Table 36 below:

Country	2008	2013
Algeria	97	99
Libya	100	100
Mauritania	24	28
Morocco	97	99
Tunisia	99.5	100

Source: IEA, 2015

Table 36: Electrification rates (%)

With respect to urban and rural access, the findings indicate access rates as below in the Table 37:

Country	National Electrification 2013	Urban Access 2013	Rural Access 2013
Algeria	99	100	97
Libya	100	100	99
Mauritania	28	47	2
Morocco	99	100	97
Tunisia	100	100	100

Source: IEA, 2015

Table 37: National electrification rates (%)

6.7.7 Development projects

A number of projects have been under consideration for some time, details are provided in Appendix 5; but their viability will be enhanced and easier to seek resources if handled under COMELEC.

6.7.8 Challenges

Soaring electricity demand, caused by economic growth, demographic changes and progressing urbanization are the key challenges in the Region. The regional approach to deal with this challenge through interconnections is a much more viable option compared to investment in additional generation and operational costs for each country in isolation but this is still encumbered by the prevailing market structures, and thus the creation of COMELEC is a step in the right direction.

6.7.9 Trends

Electricity demand is expected to increase to about 980 TWh in 2030, and Egypt will remain the largest source of demand in the region, while Libya, Morocco, and Tunisia also will experience a significant increase. Urban, industrial and rural demand currently account for 42%, 47% and 11% respectively of final electricity demand in 2010, and this split is not expected to change dramatically. The total investment needs are expected to amount to US$ 450 billion (undiscounted), of which about 40% would be for national transmission and distribution. There are three key drivers that are accelerating the development of more capacity:

- Renewable electricity generation will help offset gas-fired generation in the region, allowing more surplus gas to be exported to Europe; this could help Europe to diversify its gas import sources;
- The existence of large volumes of low-marginal cost electricity in North Africa could finally provide the security required to invest in high-voltage interconnectors under the Mediterranean. These would serve both to import surplus renewable electricity into Europe as well as to help use European excess capacity to support increasing demand for electricity in North Africa; and
- North African countries have to sustain necessary economic growth especially after the “Arab Spring”.

While the enhanced growth of the electricity market appears as a good business case, there are two main hurdles that have to be overcome; these include:

- High capital investments are required to

establish the networks; and
- Legal and regulatory reforms have to be undertaken to establish the necessary energy market laws.

Chapter 7
Analysis of Power Pools data

7.1 Introduction

Due to the diversity of Africa's natural resources – e.g. solar and wind power bases in the North, hydropower in the Central and solar in the Southern regions of Africa – there is a business case for the establishment of an interconnected network across the continent. And African nations have recognised the many benefits of power pooling.

The simplest type of pooling arrangement is the interconnection of electricity systems where national utilities rely on an interconnected network and define an arrangement in which they agree to support a neighbouring utility, country, or region during an emergency. This gives them the opportunity to improve the reliability of their power systems and system efficiency through sharing generation and reserve margins. In a "loose" pool, power is exchanged continuously and this requires contractual arrangements for power purchases and a coordinated system for dispatch. Under the more complex "tight" pool, dispatch is centralised and utilities follow a least-cost merit order of dispatch. This arrangement requires substantial investments for IT systems and the harmonisation of regulatory frameworks. The most sophisticated type of pooling is the "new pool" in which dispatching is based on the bid price of each generator rather than costs; here the wholesale price of electricity is based on competition in the market rather than being determined by a regulator.

There are 3 necessary building blocks:

- A common legal and regulatory framework which includes an inter-governmental and inter-utility memoranda of understanding, regional electricity framework laws and independent national regulators;
- A durable framework for systems planning and operation, which encompasses power pool organisation structure and interconnection planning, and system operations frameworks; and
- Finally, the most advanced is an equitable commercial framework for energy exchanges, which covers commercial rules of practice, internal dispute resolution mechanisms and minimum capabilities of system operation.

7.2 Power market development status and trends

Following the heightened realisation that power development in Africa will be best managed through Power Pools, the roadmap to enhancing regional power trade in the various Power Pools is as outlined below:

7.2.1 EAPP

Based on the proposed roadmap, the attainment of a centralised trading regime may occur between 2020 and 2025; see details in the Table 38.

Time Period	Activities
2015 – 2017	Strengthening the foundation through the establishment of interconnection networks and necessary legal, regulatory and institutional frameworks.
2017 - 2020	Expansion of power trading through expanded bilateral arrangements and day-ahead market trading (DAM)
2020 – 2025+	Implementation of a centralised trading regime and increase of volumes in DAM.

Source EAPP

Table 38: Proposed power trade road map

7.2.2 WAPP

According to the WAPP Business Plan 2016 – 2019 it is planned that 14 mainland countries will be interconnected by 2019 while a WAPP Information and Control Centre in Calavi, Republic of Benin, is due to be completed by 2018. This will have transformed into the Regional System Market Operator (RSMO) and will essentially mark the launch of a regional electricity market.

7.2.3 SAPP

The Southern African Power Pool (SAPP) was created in 1995 and is now the most advanced power pool on the continent. SAPP introduced Short-Term Energy Markets (STEM) in April 2001, which run on daily and hourly contracts. This ignited the development of a competitive energy market in the form of a Day-Ahead Market (DAM) in 2003 (with short-term contracts made anonymously through the power pool and where guarantees are required). In the meantime, given the developments in generation and transmission interconnections taking place in the region, it is expected that more counties will be operational members by the end of 2018, and there will also be an interconnection between EAPP and SAPP.

7.2.4 CAPP

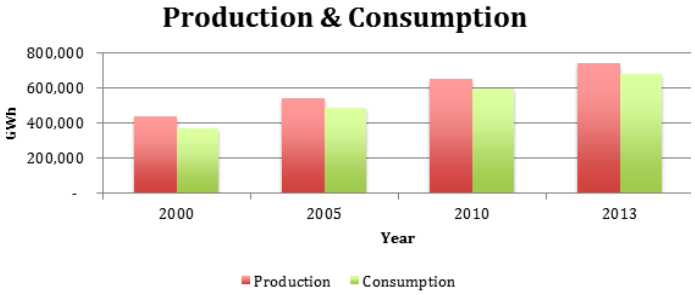
Given the developments in generation and transmission interconnections taking place in the region, it is probable that by end of 2020, CAPP may start functioning as a Power Pool for the interconnected countries, and this will continue as more countries come on board.

7.2.5 COMELEC

Given the enhanced support to regional power development, COMELEC could start its operations as a Power Pool by the end of 2018. Howevetd all that remains is to establish the market rules and supportive switchgear.

7.3 Factors for power sector growth

Based on the data provided, there has been substantial growth in both production and consumption of power across the continent between 2000 and 2013, as illustrated below in the Figure 7:



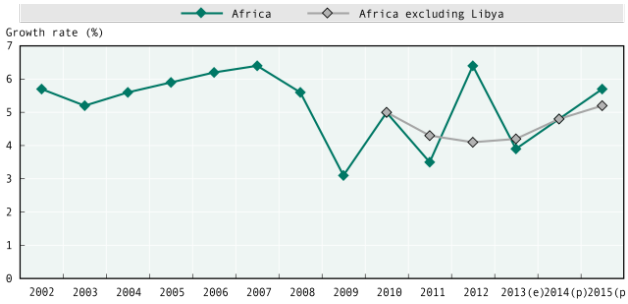
Source: AFREC, 2015

Figure 7: Electricity production and consumption

A number of factors account for this growth; these include:

7.3.1 Economic growth

Sub-Saharan Africa is seen as a new frontier of growth, and economic growth rates have shown immense potential during the last decade. This is strongly correlated with power sector growth



Source: Africa Economic Outlook, 2015

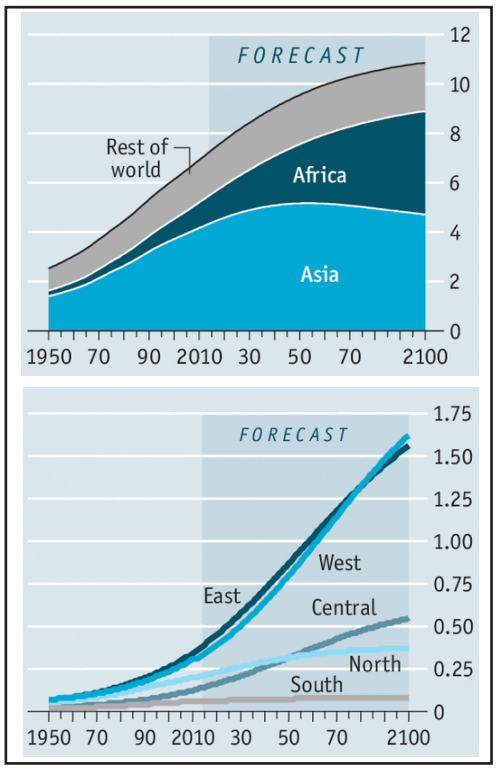
Figure 8: Africa's economic growth

7.3.2 Demographics

Population changes underway in sub-Saharan Africa will have major implications for the development of the energy sector. Growth is rapid, having increased by 270 million people since 2000 to around 940 million in 2013, and it is expected to reach one billion well before the end of this decade. This huge increase, concentrated mainly in West and East Africa, brings new opportunities, such as a rising working-age population, but also magnifies many existing challenges, such as the quest to achieve universal access to quality, sustainable energy. According to the Economist 2014, if current demographic patterns continue Africa may have 4.2 billion people by 2100, against 1.1 billion today, with the highest growth rates in Western and Eastern parts of the region, see in the Figure 9.

7.3.3 Urbanisation

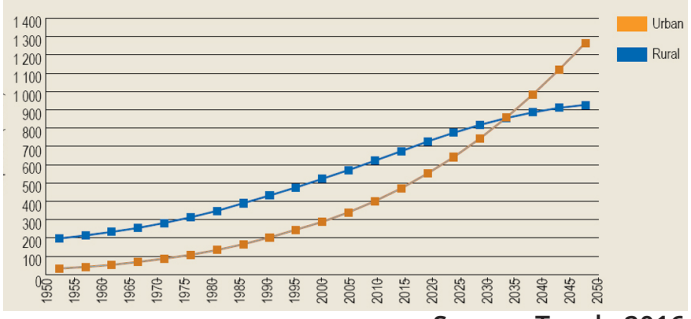
Economic growth, a rise in incomes and increasing urbanisation in most countries in Africa will lead to an increase in demand for power; according to UN data, Africa's urban population is likely to grow from the present 400 million to 1.3 billion by 2050, see in the Figure 10.



Source: Economist, 2014

Figure 9: Projected population growth in Africa

International experience shows that urbanisation has the potential to transform living standards for households, communities and nations. With the right institutions, infrastructure and policies in place, cities can contribute to accelerated economic development, increased private investment and job creation. Policy priorities need to shift from trying to contain and eliminate the growth of informal settlements, to harnessing the benefits of concentrated economic activity in higher productivity and entrepreneurial dynamism. Ordinary people must be enabled to access emerging opportunities and find their position in urban labour markets, education systems and social networks.

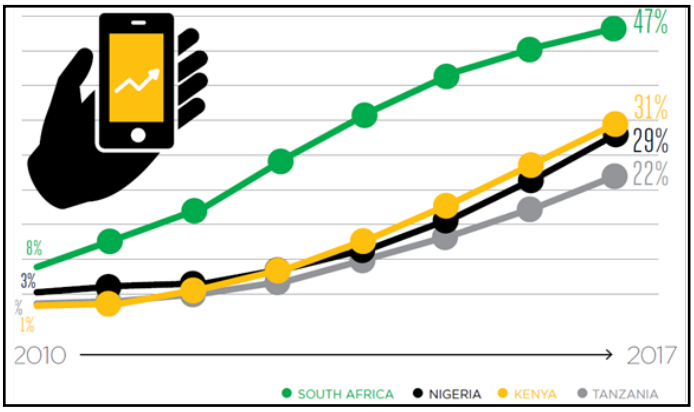


Source: Turok, 2016

Figure 10: Urbanisation growth in Africa

7.3.4 Technology

Innovations like the mobile phone, affordable agro-processing equipment and an increasingly enlightened rural population have compelled the energy sector to increase access in order to meet the required power needs of the population – electricity is no longer a privilege for the urban elite.



Source: ITU, 2016

Figure 11: Smart phone growth in selected African countries

7.3.5 China

China is investing significantly in the continent. According to African Economic Outlook 2015, foreign direct investment from China rose dramatically from US$1.5 billion in 2005 to US$15 billion in 2011; about 65 percent of this is in sub-Saharan Africa, of which just over a third goes directly into the energy sector. According to the IEA, between 2010 and 2015 Chinese contractors constructed and connected more than 7 GW of generation capacity additions; these completed power plants represent 30% of sub-Saharan African capacity additions in this five-year period and 46% if South Africa is excluded.

7.3.6 International frameworks

A number of global initiatives are engaged in the promotion of increased prosperity and economic development in Africa by improving electricity security, they include:

1. **Power Africa:** Launched by former US President Barack Obama in June 2013, Power Africa aims to add more than 10,000 megawatts of clean, efficient electricity generation capacity and provide access for more than 20 million people and commercial entities through expansion of mini-grid and off-grid solutions in addition to enhancing energy resource management capabilities, allowing partner countries to meet their critical energy needs and achieve sustainable, long-term energy security.

2. **Sustainable Energy for All (SE4ALL):** A partnership between the UN and the World Bank, SE4ALL has three objectives:

- Ensure universal access to modern energy services;
- Double the global rate of improvement in energy efficiency; and
- Double the share of renewable energy in the global energy mix.

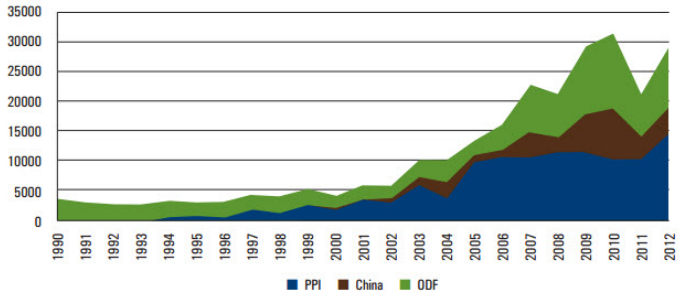
3. **Africa-EU Millennium Development Goals initiative:** Launched at a summit of the UN General Assembly in New York in 2010, the EU's Millennium Development Goals initiative is helping African, Caribbean and Pacific (ACP) nations to reach the Millennium Development Goals (MDGs) with funding of about €1 billion of funds from the 10th European Development Fund (EDF). By the end of 2013, the MDG initiative funded 69 projects implemented by non-governmental organisations, member state agencies and international organisations in 46 countries of Africa, the Caribbean and the Pacific;

4. **Tokyo International Conference on African Development (TICAD):** Launched in 1993 by the Government of Japan, TICAD promotes Africa's development, peace and security through the strengthening of relations in multilateral cooperation and partnership. TICAD contributes to the facilitation and promotion of high-level

policy dialogue between African leaders and Africa's development partners on issues pertaining to economic growth, trade and investment, sustainable development, human security, peace and stability and government. Being a multilateral partnership, TICAD also actively promotes South-South and triangular cooperation, in addition to traditional cooperation.

7.3.7 Private sector growth

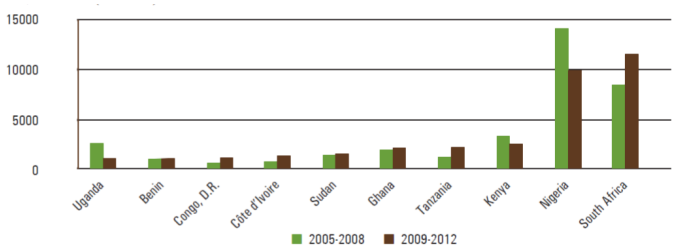
The prospects for increased growth in private sector investment, manifested by its ability to mobilise resources to fund viable projects, is dependent on electricity sector reforms and restructuring to render the utilities more efficient, viable and attractive for alternative sources of financing.



Source: Gutman, 2015

Figure 12: External infrastructure investment commitments 1990 - 2012

Just like global investment, Private Participation in Infrastructure (PPI) in sub-Saharan Africa goes mainly to a few countries—especially South Africa and Nigeria, which rank eighth and ninth globally, respectively. In fact, over the 2009-2012 period, South Africa and Nigeria received PPI worth US$11.6 billion and US$10.0 billion respectively (and US$9.3 billion and US$14.5 billion respectively, in 2005-2008). Kenya is the third-largest PPI recipient in the region, receiving much less - US$2.6 billion - over the same period; see in the Figure 13.



Source: Gutman, 2015

Figure 13: Top 10 PPI recipients in sub-Saharan Africa

With the growth of the private sector and increased demand for infrastructure development, Africa has to attract more support from the private sector, this will necessitate a number of policy reforms, including:

1. **Provision of clear, consistent and transparent regulations:** Nothing makes the private sector more nervous than uncertainty, which is why long-term transparency, a track record of following through on commitments, and sticking to policy decisions are so critical;

2. **Allocation of risk:** Every investment has risks that have to be appropriately allocated among the government, the private sector and, in some cases, the national utility itself. The general rule for risk allocation is that the party that is most able to manage the risk is the one that should hold it;

3. **Provision of a credible off-taker** that has the capacity to buy the electricity from the generation companies is very important and critical

4. **External risk guarantors:** Partial risk guarantees from multilateral institutions, such as the African Development Bank or the Multilateral Investment Guarantee Agency, enhance private sector confidence.

7.3.8 Political will

Over the recent past, due to a number of factors that include international conventions and public awareness, governments have

demonstrated high political goodwill in supporting necessary reforms in the energy sector making it more efficient and attractive for alternative financing.

7.3.9 Increased public awareness

Public awareness of the benefits associated with electrification have continued to grow, in some cases supported by needs such as charging mobile phones that by far have a much higher penetration, leading to demands on governments to provide the necessary services.

7.3.10 Regional cooperation

The establishment of regional Power Pools have the potential to lower capital investment requirements across the region, reduce system operational costs and create the appropriate institutional framework for cross-border electricity trade.

7.4 Way forward

7.4.1 Challenges ahead

In spite of this commendable progress, there is still a lot to be done and the establishment and growth of the Power Pools provide an excellent opportunity to realise the ultimate objective of the social and economic transformation of the African continent. It is estimated that by encouraging regional integration, sub-Saharan Africa would save US$50 billion in generation capital spending, while spending only an additional US$9 billion for transmission. In addition, according to the African Development Bank study "PIDA Energy Outlook report, 2014 ", full regional integration would help to save, cumulatively by 2040, US$1,117bn (or US$ 43bn p.a.) and energy efficiency policies are expected to save 139 GW (16.7%) of capacity needs. This net saving of US$43 billion represents a 9% reduction in total generation capital spending from the national case scenario.

However there are still a number of challenges that need urgent attention, these include:

- Lack of infrastructure: the need for infrastructure requires no over-emphasis as no power trade/exchange can take place without the necessary infrastructure in place; so focus should be put on the following:
  a. Building the international lines and facilities to expand the geographic extent of the regional grid and electric power trading;
  b. Developing adequate technical and commercial capacity; and
  c. Additional resources

- Lack of national strategies: Many countries still lack a comprehensive strategic framework in the context of national goals and objectives to help guide the roles and responsibilities for all players including government utilities, the private sector, civil society and development organisations;

- Utility financial distress: These are mainly attributed to below-cost tariffs, weak management and political interference;

- Universal standards: The non-discriminate application of technical standards in urban and rural areas, where demand is significantly much lower, is not very supportive of the rural electrification process; low-cost options like Single Phase Reticulation, Single Wire-Earth Return, Shield Wire Systems and the associated cost-effective design of transmission expansion should be adopted across the continent;

- Politics: The ultimate goal to harness energy resources for the socio-economic transformation of Africa will necessarily hinge on political will and support. The need to harmonise power sector regulatory policies and the adoption of regional master

plans to guide national development plans cannot be compromised;

- Afro-pessimistic perceptions: Unfortunately Africa is still perceived as a single country or bloc often framed by decades-old stories and images of civil strife, terrorism, corruption, famine, disease and poor infrastructure; these afro-pessimist myths and negative perceptions may be deal breakers for potential investors.

7.4.2 Recommendations

- **Mobilise investments for physical intra-regional infrastructure:** This would include a strategy to mobilise major domestic resources such as pension funds or infrastructure bonds;

- **Conducive legal and regulatory framework for private sector participation:** This would include legally empowering the Power Pools to act on behalf of RECs (and governments), particularly on power deals. In this way a private sector entity wanting to invest in a regional project would have to deal with one entity instead of a complicated deal-structure with many countries;

- Continued strengthening of the institutional capacity and skills of the Power Pools and directorates in charge of energy in the RECs: A certain focus should be paid to enhancing the capacity and skills for structuring and negotiating power deals with the private sector, e.g. PPA (Power Purchase Agreements).

1. Appendices

1.1 Appendix 1: Priority projects in EAPP

Ruzizi 3 – 145MW	Feasibility stage
Ruzizi 4 – 287MW	Feasibility stage
Kivu I – 100MW	Feasibility stage
Kivu II – 200MW	Feasibility stage
Gibe IV – 1468 MW	Under construction
Karuma – 700MW	Under construction
Isimba - 180MW	Under construction
Grand Renaissance dam 6,000 MW	Under construction
Ethiopia – Kenya 500kV	Under construction
Ethiopia – Sudan 500kV	Feasibility stage
Tanzania – Uganda 220kV	Feasibility stage

1.2 Appendix 2: Priority projects in WAPP

Name of Project	Year of operation
Projects Under Implementation	
330 kV Volta (Ghana) – Lome "C" (Togo) – Sakete (Benin)	2017
225 kV Bolgatanga (Ghana) – Ouagadougou (Burkina Faso)	2018
330kV Aboadze – Prestea – Kumasi – Bolgatanga	2018/2020
140MW Gouina Hydropower Project under OMVS	2019
OMVG (Senegal, Gambia, Guinea, Guinea Bissau)	2019/2020
Cote d'Ivoire – Liberia – Sierra Leone – Guinea Interconnection Project (CLSG)	2018
64 MW WAPP Mount Coffee Hydropower	2017
450MW Maria Gletta Hydropower Project (Benin)	2020
450MW Domunli Hydropower Project (Ghana)	2020
Rehabilitation of 760MW Kainji and 540MW Jebba Hydropower stations in Nigeria	2016
220MW Tiboto Hydropower Project (Ivory Coast and Liberia)	2021
Resource mobilisation	
330kV Ivory Coast – Ghana interconnection	2019
330 kV Nigeria – Niger – Togo/Benin - Burkina Interconnection Project	2020
225kV Ghana – Burkina Faso – Mali Interconnection Project	2020
225 kV Guinea – Mali Interconnection	2020
Under review, development (studies, etc)	
760kV Nigeria Super Grid	-
330kV Nigeria – Niger – Burkina – Togo/Benin (Northcore)	2020
128MW Kassa Hydropower Project in Guinea	-
86MW Bikongor Hydropower Project in Sierra Leone	-
150 – 450MW Hydropower projects in OMVS zone	2020
147MW Adjarala Hydropower Project (Benin/ Togo)	2019
515MW Souapiti Hydropower Project in Guinea	2021
30MW Solar Park in Mali	-

Source: WAPP

1.3 Appendix 3: Priority projects in SAPP

No.	Project Name	Voltage (kV)	Expected date	Status
1	Zambia – Tanzania	400	2018	Construction
2	ZIZABONA	330	2019	Feasibility
3	Central Transmission Corridor	330	2019	Feasibility
4	Mozambique – Malawi	400	2020	Feasibility
5	Namibia – Angola	400	2019	Feasibility
6	DRC – Angola	400	2018	Feasibility
7	Mozambique STE	HVDC/AC	2022	Feasibility
9	MOZISA	400/ 500	2022	Feasibility
8	BOSA	400/ 500	2022	Feasibility
9	Grand Inga Integration	HVDC/AC	2024	Feasibility
10	KUDU	HVAC	2022	Feasibility

Source: SAPP

1.4 Appendix 4: Priority projects in CAPP

Name of project	Current Status
Memve'le 220MW in Cameroon	Under construction
Poubara (320MW) in Gabon	Under construction
Djibloho (120MW) in Equatorial Guinea	Under construction
Lom Pangar HEP (30MW) in Cameroon	Under construction
Zongo II (120MW) in DRC	Under construction
Kakokobola (80MW) in DRC	Under construction
Kakobola (10.5MW) in DRC	Under construction
Nachtigal (420MW)	Under construction
Inga 3 (3,500MW) in DRC	Feasibility status
Chollet (620MW) on Cameroon – Congo border	Feasibility status
Uganda-Rwanda interconnection (172km at 220 kV) and associated substations	Feasibility status
Kenya-Uganda interconnection (260km at 400 kV and 220 kV) and associated substations;	Feasibility status
Burundi, DRC and Rwanda interconnection (371km at 220 kV) and associated substations	Feasibility status
Burundi-Rwanda Interconnection (143 km at 220kV) and associated substations	Feasibility status
Bendera in CAR	Feasibility status
Ruzizi (145MW) on Rwanda/Burundi/DRC border	Feasibility status
Ruzizi 4 (287MW) on Rwanda/Burundi/DRC border	Feasibility status
Busanga (240MW) in DRC	Feasibility status

1.5 Appendix 5: Priority projects in COMELEC

1. **Algeria – Spain:** A ±500kV bipolar kV DC line is proposed as a link between Spain and Algeria; with a capacity of 2000MW;

2. **Algeria – Italy:** A 330km 500MW mono-polar 500kV DC is planned between Algeria and Italy;

3. **Tunisia – Italy:** This interconnector would be in 2 stages, involve Stage 1: A 400kV mono-polar with a capacity of 500MW and Stage 2: A ±400kV bi-polar with a capacity of 1,000MW; is also planned with a 1,200MW gas fired plant, 800MW would be for export to Italy, 200MW for local needs and rest of capacity would be for RE export estimated at 200MW;

4. **Libya – Italy:** this interconnector covering a distance of about 550km would also be in 2 stages; Stage 1: A 500kV mono-polar with a capacity of 500MW and Stage 2: A ±5,000kV bi-polar with a capacity of 1,000MW;

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