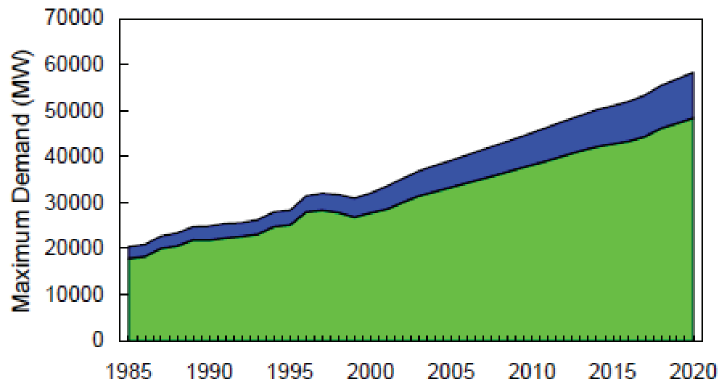
2 PROJECT RATIONALE

2.1 THE ENERGY GAP IN THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY REGION

For the entire Southern African Development Community (SADC) region, power consumption has been increasing at a rate of about 3 percent (%) per annum, implying an *additional* requirement of 1,200 megawatts (MW) per year (*Figure 2.1*). The increase in demand may even accelerate, as most SADC countries have set themselves ambitious targets for economic growth – in most cases exceeding 5% per year.

Figure 2.1 Southern Africa Power Forecasts



Source: IWRM, 2008

2.2 ENERGY CONSUMPTION AND PRODUCTION IN ZAMBIA

2.2.1 Energy Consumption (Zambia)

According to the Zambia Development Agency (ZDA; 2014) the country's economy has been growing at an average of 5% per annum over the past 10 years and as a result, the demand for energy has also been rising. This is due to economic activities in the country particularly in the mining, manufacturing and agriculture sectors.

The Japan International Cooperation Agency (JICA) (2010), in their power system development master plan for Zambia, introduced three power forecast scenarios, based on differences in respect of macro-economic conditions, population growth, and customer increase rate, namely base, high, and low cases (*Figure 2.2*).

In this study (JICA; 2010), gross domestic product (GDP) growth is assumed to be 6 % p.a. (equivalent to the actual growth rate from the mid- 2000s) in the base-case scenario, 7 % p.a. (the target figure in the government's economic development plan) for the high-case scenario, and 5 % p.a. rate in the low-case scenario (as reported above by the ZDA (2014)). Population growth is forecast at 2.3 % p.a. following the historical trend. The electrification rate is forecast to increase at the rate of 4 % p.a., equivalent to the increase in the number of customers in the residential and commercial sector for the past five years, in the base-case scenario, 6 % per annum (p.a.) in the high-case scenario, and 3.5 % p.a. in the low-case scenario.

As of December 2012, total energy demand exceeded internal generation capacity [(1)]. This was as a result of the expansions in the mining and manufacturing sectors as well as overall expansions in the economy and population.

The current power deficit has resulted in prolonged load shedding and power cuts, which have occasionally affected trade and production.

2.2.2 *Energy Production (Zambia)*

ZESCO Limited

The Zambian electricity power system is operated as part of an interconnected power system linking South Africa, Zimbabwe, and Democratic Republic of Congo (DRC). Currently there are three major electricity suppliers including: ZESCO Limited, which generates, transmits, distributes and supplies electricity throughout Zambia; Copperbelt Energy Corporation (CEC) in Kitwe which is a net transmitter of electricity purchased from ZESCO at high voltage and distributed to the mining industry based on the Copperbelt; and Lunsemfwa Hydro Power Company (LHPC) based in Kabwe which is an independent power producer generating 48 MW of power that it sells to ZESCO Limited under a Power Purchase Agreement.

There is also the Rural Electrification Authority (REA) which deals with the cause for increasing access to electricity in the rural areas and the Energy Regulation Board which is the regulator of the energy sector in Zambia. Other participants in the industry include small-scale generators and solar based energy services companies supplying power to some rural areas.

Sources of Energy

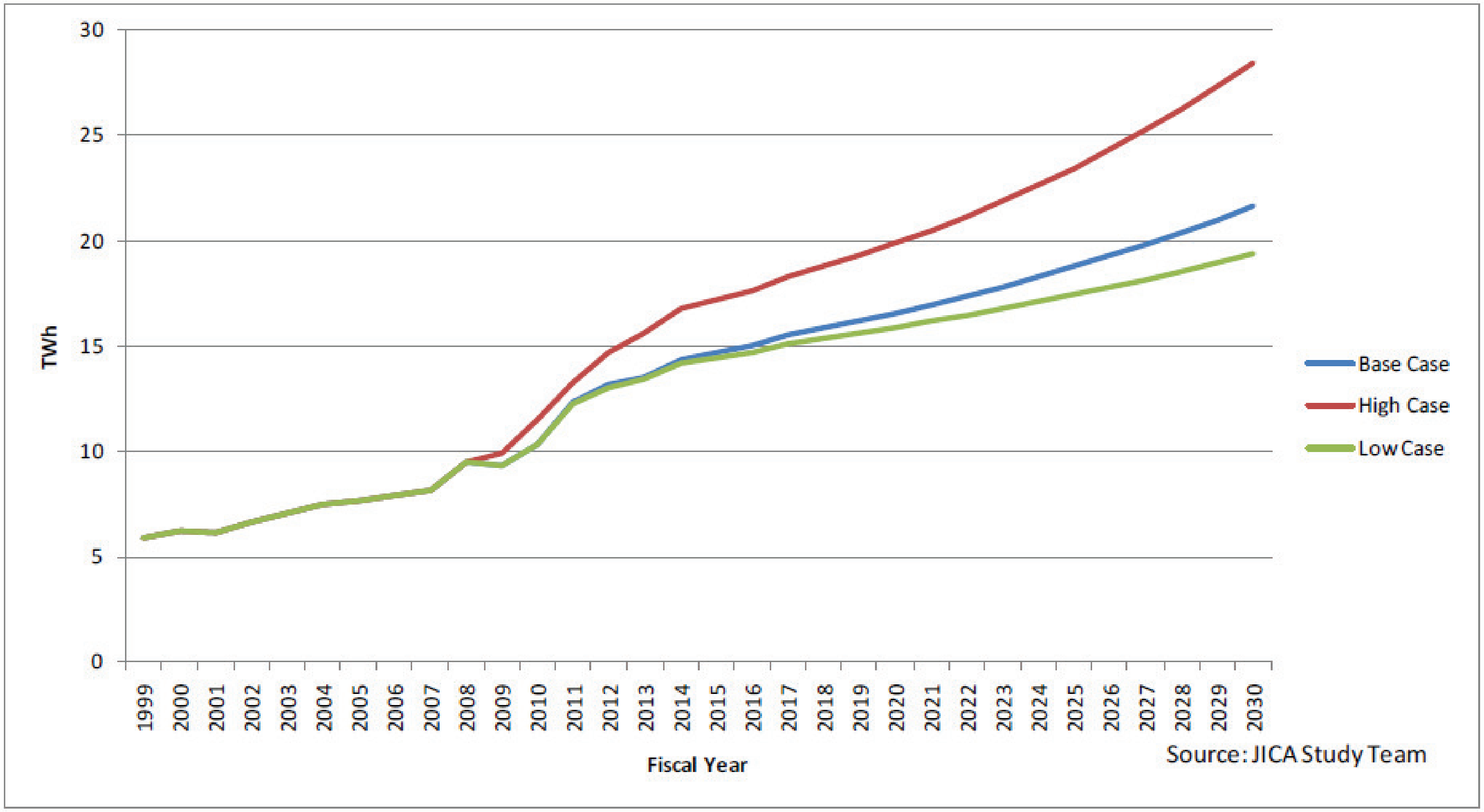
The main sources of energy in Zambia include biomass, electricity, petroleum, coal and renewables, specifically solar, wind and hydropower.

<u>Biomass</u>
According to ZESCO Limited (2009) [(2)] the degree of electrification in Zambia is very low. 22 % of the population have direct access to grid electricity, 0.028 % of the population have direct access to isolated electric systems, and 77.972 % of the population have no access to electricity at all. This proportion

(1) Policy Monitoring and Research Centre (PMRC), 2013. *The State of the Energy Sector in Zambia: Implications for Industrial Development, Jobs and Poverty Reduction Background Note*
(2) ZESCO Ltd, 2009, Business Development Department, General Description Of The Electricity System

of the population in Zambia therefore relies on biomass as the main source of energy.

Figure 2.2 *Comparison of Demand under three Demand Forecast scenarios*



Source: JICA (2010)

Hydropower

The three major Zambian hydropower plants, namely; Kariba North Bank, Kafue Gorge, and Victoria Falls are owned and operated by ZESCO. These generated enough power during the 2004/05 financial year to almost match electricity consumption in Zambia (Rural Electrification Master Plan Study, 2007). Furthermore, ZESCO owns and operates four Mini Hydropower Plants. These mini plants include: Lusiwasi, Musonda Falls, Chishimba Falls and Lunzua River. A plant at Chishima is also being proposed. These plants were initially developed as power sources for independent power networks in rural areas of Zambia. They are currently being upgraded in order to allow greater energy generation as highlighted in *Table 2.1*.

Table 2.1 Status of ZESCO's Mini Hydropower Plants

Project	New Capacity (MW)	Status
Lusiwasi Lower	86	Tendering
Lusiwasi Upper	15	Contract awarded
Lunzua	14.8	Construction
Musonda Falls	10	Construction
Chishimba	14.8	Tender documents

Source: ZRA, 2014

Major hydropower plants contributed 1, 668 MW of the total generation capacity (98% of total national energy production) and small hydropower plants contributed 24 MW (1.4% of total national energy production), in the year 2006.

The Zambia Development Agency (ZDA, 2014) (1) states that hydro-power is the most important energy source in the country, after wood fuel. It further states that there has not been any major addition to the country's generation capacity in the last 20-30 years, despite the huge potential in hydro resources. ZDA estimates that even though Zambia possesses 40% of the water resources in the Southern African Development Community (SADC), the Country has about 6,000 MW of unexploited hydro power potential; currently less than 2,259 MW has been developed, as indicated in *Table 2.2*.

Table 2.2 Installed Generation Capacity in Zambia

No	Power Station	Installed Capacity (MW)	Type of Generation	Operator
1	Kafue Gorge	990	Hydro	ZESCO
2	Kariba North Bank	1,080	Hydro	ZESCO
3	Victoria Falls	108	Hydro	ZESCO
4	Lunsemfwa and Mulungushi	56	Hydro	Lusemfwa Hydro Corp
5	Small Hydros (combined)	25	Hydro	ZESCO
6	Isolated Generation	8	Diesel	ZESCO
7	Gas Turbine (stand by only)	80	Diesel	Copperbelt Energy Corp
	Total Installed Capacity	2,347		

(1) Zambia Development Agency (2014) *Zambia Energy Sector Profile*

Source: ZDA, 2014. Zambia Energy Sector Profile

Coal Fired Power Stations

Coal accounts for 5% of national energy requirements: the largest consumer is the mining industry, followed by the manufacturing sector (United Nations Development Programme, 2011). Maamba Collieries Limited is Zambia's largest coal supplier, followed by Collum Coal Mines. Currently Maamba Collieries mine two open cast mines in the Kanzize and Izuma Basins in the Southern Province. However, due to the paralysis of mine operations, the Zambian government transferred its 100% stake in the company to ZCCM Investment Holdings Plc (ZCCM-IH). ZCCM is expected to revamp operations at the coal mine and transform it into a viable business entity, thus improving coal supply for enhanced industrial production (ERB, 2008).

Diesel Generators

According to the ERB (2008), Diesel Power Plants contributed 8MW (0.5% of total national energy production) in 2006. The following are Diesel Power Stations owned and operated by ZESCO:

- Mwinilunga;
- Kabompo ;
- Zambezi;
- Mufumbwe;
- Kaoma (abandoned due to the area being linked with the National Grid);
- Luangwa ;
- Lukulu;
- Chama; and
- Kaputa.

Electricity Imports/Exports

Due to the power deficit that is currently being experienced in the country, ZESCO currently only exports excess off-peak and low voltage power. High power off peak exports during the year 2007 was exported to the Zimbabwe Electricity Transmission and Distribution Company (ZETDC) and Eskom of South Africa. Zambia exported power in small quantities at low voltage to Botswana, the Democratic Republic of Congo, Namibia, Tanzania, and Zimbabwe. ZESCO exports were 337,678 MWh in 2007 compared to 287,772 MWh in 2006 representing an increase of about 17.3%.

Energy imports on the other hand were 232,953 MWh and 54,409 MWh in 2007 and 2006 respectively, representing an increase of 328 percent in one year (ERB, 2008).

2.2.3 *Electrification (Zambia)*

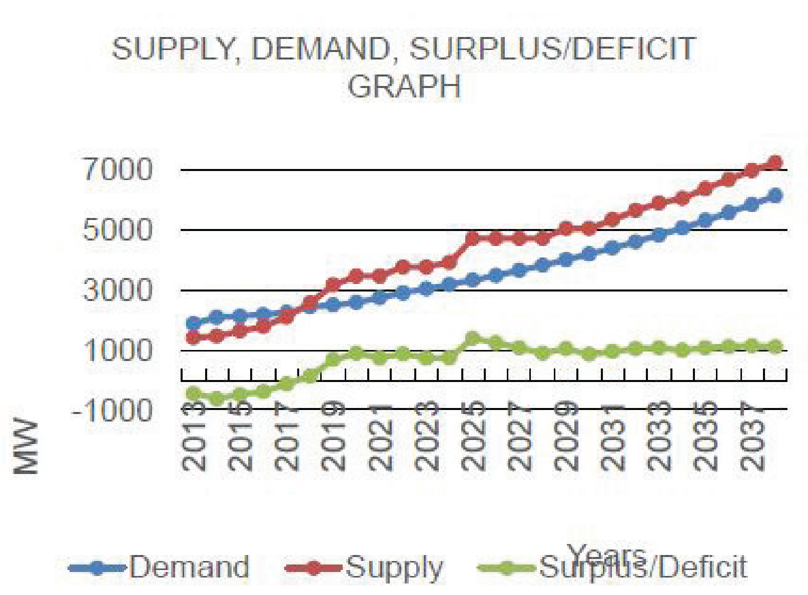
In Zambia, despite some, albeit small levels of energy exports, the household electrification rate remains at approximately 20 % countrywide and only 2 % to 3 % in rural areas. The Poverty Reduction Strategy Paper published in 2002 set a mid-term target to achieve a household electrification rate of 25 % by 2010; 50 % for urban areas and 15 % for rural areas (JICA 2008).

2.3 *ENERGY PRODUCTION AND CONSUMPTION IN ZIMBABWE*

2.3.1 *Energy Consumption (Zimbabwe)*

According to the Ministry of Energy and Power Development's National Energy Policy of 2012, there is a net deficit in the supply of electrical power in Zimbabwe. The country requires nearly 2200 megawatts (MW) in winter at peak, but generation locally can't meet the demand as on average 1400 MW are being produced; energy imports and load shedding is used to cover for the deficit, with extensive dependency on load shedding [1]. The power sector in Zimbabwe, has according to the Zimbabwe Energy Regulatory Authority (ZERA, 2015), been facing many challenges, that include lack of investment, lack of capital, and old equipment.

Figure 2.3 ***2010 - 2030 Supply: Deficit graph for Zimbabwe***



Source: ZETDC (2015)

2.3.2 *Energy Production (Zimbabwe)*

Zimbabwe Electricity Supply Authority (ZESA)

The Ministry of Energy and Power Development has overall responsibility for the energy sector in Zimbabwe. The Ministry supervises and oversees the performance of state-owned enterprises such as Zimbabwe Electricity Supply

(1) http://www.zimbabwesituation.com/news/zimsit_government-lethargy-on-power-investment-costly/

Authority (ZESA). ZESA represents Zimbabwe in the Southern African Power Pool.

ZESA is a state-owned company whose task is to generate, transmit, and distribute electricity in Zimbabwe. ZESA however delegates this responsibility to its subsidiaries; namely, the energy generating company Zimbabwe Power Company (ZPC), and the Zimbabwe Electricity Transmission and Distribution Company (ZETDC).

ZPC incorporates all the power generation plants of Hwange, Kariba and various small thermal power stations (Harare Power Station, Bulawayo and Munyati Power Stations). ZETDC, on the other hand, develops the Transmission and Distribution Network, and transmits, distributes and supplies electricity to consumers.

In addition to ZPC, there are also IPPs in Zimbabwe. According to ZERA (2015), although there are currently 12 licensed IPPs in Zimbabwe, only six are currently operational (1). Out of the six operational IPPs, three are mini IPPs, while the other three IPPs are co-generators (meaning they produce for their consumption as well as for sale).

The three operating mini hydro-stations include Nyamhingura (1.1MW), Pungwe (2.7 MW) and Duru (2.2 MW). Co-generators include Triangle, Hippo Valley and Chisumbanje. Hippo Valley and Triangle generate 40MW and sell at least 5 MW if they have excess, while Chisumbanje has a capacity of 18 MW, with a capacity to sell 6 MW.

There is also the Rural Electrification Authority (REA) and the rural electrification programme has seen more than 5000 rural institutions, farms, villages, borehole, dam points and irrigation schemes electrified to date (2).

Sources of Energy

The main sources of energy used in Zimbabwe comprise wood fuel which provides the bulk of the total energy supply (61%) (3). Most rural areas are facing fuel-wood shortages as a result of agricultural land use and unsustainable harvesting. Demand for wood fuel already exceeds supply in Manicaland, Mashonaland East, the Midlands and Masvingo provinces, which are heavily populated. Mashonaland Central and Matabeleland North are fast reaching the same situation.

(1) https://www.newsday.co.zw/2013/04/25/six-ipps-functional-out-of-the-12-licensed/
(2) Zimbabwe Ministry of Energy and Power Development (2014), Rural Electrification Programme http://www.energy.gov.zw/index.php/power-development/rural-electrification-programme
(3) Zimbabwe Ministry of Energy and Power Development (2012) National Energy Policy

Generation capacity is currently provided mainly by hydropower and coal. *Table 2.3* shows current available dependable generation capacities of existing local power plants.

Table 2.3 Current Available Dependable Generation Capability

Dependable Plant Capabilities (Maximum)	Capacity(MW)
Hwange (1-6)	700
Harare	30
Bulawayo	20
Munyati	20
Total Thermal Capacity (MW)	**770**
Duru	2.2
Nyamingura	1.1
Pungwe A	2.7
Pungwe B	15
Kariba	750
Total Hydro Capacity (MW)	**771**
Total Local Capacity (MW)	**1541**

Source: ZETDC (2015)

The Kariba South hydropower plant has a total installed capacity of 750MW. The Kariba South Power Station has an operational efficiency of above 90 %. Depending on inflows into the lake, the station can generate a maximum of 5000 GW/hrs with a load factor of 80 %.

In terms of thermal capacity, most of the thermal fleet is approaching or has exceeded its economic life, and are running below their installed capacities due to age related constraints (ZETDC, 2015). The coal market is dominated by Makomo Resources and the Hwange Colliery Company. The Hwange Power Station is the largest coal-fired power station in Zimbabwe with 920 MW installed capacity, but a current operational capacity of 700 MW. This power station is the 14th largest thermal station in the Southern African region. The station was built in two stages. The 4 x 120 MW units were commissioned between 1983 and 1986 and the 2 x 220 MW were commissioned in 1986 and 1987. The station's design largely represents technologies of the late 1960s. All six units are available and the station currently generates about 40 % of the country's electricity needs. The Hwange Power station operates as a base load station, with its availability averaging 80% [(1)].

Future Generation Capacity

The historic System Development Plans were never implemented due to funding constraints. This resulted in significant under investment in Generation, Transmission and Distribution sectors of the industry. The current persistent load shedding and poor Transmission and Distribution network reliability are a result of the significant underinvestment in the sector to replace, rehabilitate and expand plant and network capacity (ZETDC, 2015).

(1) http://www.zpc.co.zw/powerstations/1/hwange-power-station

Zimbabwe's electricity generation capacity and energy exported is expected to improve significantly in 2018 after the completion of a number of planned new energy developments. According to the Ministry of Energy and Power Development, short term projects, which are projects with short construction lead times that can effectively address load shedding, and proposed as part of the 2015 System Development Plan, are included in *Table 2.4*.

Table 2.4 Short term Generation Projects

Plant	Capacity (MW)	Commissioning Year
Demand Side Management (DSM)	50	2015
Power Imports	200	2015
Bulawayo	90	2016
Munyati Repowering	90	2016
Harare Repowering	100	2016
ZPC Diesel	120	2017
Gairezi Hydropower	30	2018
Hwange Life Extension Stage1, 4 Units	480	2020
Hwange Life Extension Stage2, 2 Units	440	2020

Source: Ministry of Energy and Power Development website (www.energy.gov.zw) and ZETDC (2015)

A summary of the complete generation system development sequence, with projects recommended for development, as described in the System Development Plan, is indicated in *Table 2.5*.

Table 2.5 Planned System Development Sequence in Zimbabwe

Development Sequence No.	Plant	Capacity / MW	Year
1.	DSM	50	2015
2.	Power Imports	200	2015
3.	ZPC Diesel	120	2017
4.	Gairezi	30	2018
5.	Bulawayo	90	2016
6.	Harare Repowering	100	2016
7.	Munyati Repowering	90	2016
8.	Kariba South Extension	300	2018
9.	CASECO	600	2018
10.	Hwange 7&8	600	2019
11.	Hwange Life Extension Stage1, 4 Units	480	2020
12.	Hwange Life Extension Stage2, 2 Units	440	2020
13.	Batoka Gorge	800	2022
14.	Devil's Gorge	600	2025
15.	Lusulu Unit 1	250	2032
16.	Gokwe North Unit 1	300	2033
17.	Lusulu Unit 2	250	2036

Source: Zimbabwe Investment Authority (ZIA) website and ZETDC (2015)

Power Imports

As can be seen in *Table 2.6* there is currently not a significant amount of dependable power for import within the SAPP utilities, with only 50 MW imported as firm supply, and the balance, which varies according to availability.

Table 2.6 ***Zimbabwe Import Contracts***

Source	Status of Contract	Contract Capacity (MW) and Nature of Capacity
HCB	Firm and Non-Firm	50 MW firm
	Expires	Non-firm Varies on availability
SNEL	Firm	0MW
	Expired 28 February 2013	
ESKOM	Non-firm	Non-firm Varies from 0 to 450 MW, depending on availability
	PPA valid up to march 2015	
ZESCO	Non-firm	Non-firm Varies from 0 to 300 MW depending on availability
NamPower Exports	150MW	150 MW
Total Firm		50 MW

Source: ZETDC, 2015

Energy Efficiency and Demand Side Management (DSM)

A study commissioned by ZERA recently established that the country could save 250 MW, about a quarter of the country's current average generation, by implementing energy efficiency measures in key sectors of the economy.

The ZETDC is currently engaged in DSM activities that are expected to realise substantial energy savings that would go a long way in alleviating the current energy deficit. Activities being carried out to influence energy consumption patterns are summarised in *Table 2.7*.

Table 2.7 ***DSM and Energy Efficiency Initiatives Summary***

Initiative	2015 MW	2016 MW	2017 MW	2018 MW	Total MW
LED lighting	110	110			220
LED Commercial lighting	30	30			60
Solar water heaters	10	10	10		30
Potential savings (MW)	171	170	30	15	386

Source: ZETDC, 2015

Diesel Plants

The ZPC diesel plant is engine based and has favourable construction lead times and short payback periods, characteristics that make it suitable for short-term power supply shortage mitigation. Beyond the short term period, this plant can viably serve as an emergency, reserve and peaking power plant, owing to its attractive operational characteristics (ZEPTC, 2015).

Hydropower

The Ministry of Energy and Power Development (2012) states that the development of large-scale and small-scale hydropower must be prioritised as a strategy for increasing the share of renewable energy, as required by the Energy Regulatory Authority (ERA) Act [Chapter 13:23] and international obligations for environmentally sustainable energy services.

Large-scale hydropower on the Zambezi and small-scale hydropower on internal dams and perennial rivers represent a significant renewable energy resource for meeting local and regional electricity demand.

Expansion works which commenced at Kariba South in 2013, are expected to be completed in 2017, adding 300 MW to the national grid (1). The Batoka Gorge project has a potential capacity of 1600 MW for both the Zimbabwean and Zambian sides. Feasibility studies are ongoing and the project lead time is about 7-8 years from financial closure.

Small-scale hydropower development projects, which include in-land dams and smaller run-of-river schemes, have the potential to add up to 120 MW to the national grid. Presently, five mini-hydro schemes with a projected output of 24.35 MW, have been approved by ZERA for development.

<u>Coal</u>

Brownfield projects (rehabilitation and expansion projects) are being developed at the Bulawayo, Munyati (both December 2017) and Harare Thermal Power Stations (December 2015), as well as rehabilitation and expansion works at Hwange Thermal Power Station (December 2017). These power stations are all currently operating at reduced capacity: Hwange Thermal Power Station has an installed capacity of 920 MW but a dependable capacity of 705 MW; Harare Thermal Power Station has an installed capacity of 120 MW and a dependable capacity of 30 MW; Bulawayo Thermal Power Station has an installed capacity of 120 MW and a dependable capacity of 20 MW; and Munyati Thermal Power Station has an installed capacity of 100 MW and a dependable capacity of 20 MW. All of the major power stations in Zimbabwe are old with the small thermal plants commissioned between 1942 and 1957, Kariba in 1959-1962 and Hwange in 1983-1987. Timely rehabilitation of the ZPC thermal fleet therefore is a critical path activity of the generation system development plan.

An independent power producer (IPP) who is at an advanced stage of project planning, with most agreements signed, and moving to the construction phase of a 660 MW power plant at Gwayi (100 km from Hwange), is looking to exploit coal resources that are deep underground through inclined shaft mining (as opposed to open cast mining that is employed by both Makomo Resources and Hwange Colliery), as a way of ensuring coal supply security and stability for their 660 MW power plant and the market.

(1) https://www.newsday.co.zw/2013/06/18/zimbabwe-energy-crisis-to-ease-in-2017/

A 1000 MW Coal Ash power station is also currently being proposed by an IPP to exploit millions of tonnes of coal ash that has accumulated since the initial commissioning of the Hwange Power Station in 1983. This technology will utilise waste coal ash from Hwange Power station, thereby helping to clean up the environment and reduce the subsequent environmental damage due to current rates of coal ash deposition.

Solar Energy

Zimbabwe's solar energy potential of 16–20 megajoules (MJ)/m^2/day is greatly underexploited. There is an enormous potential for use of solar photovoltaic (PV) and solar water heaters that has not yet been exploited. The ZERA and ZETDC have registered an increasing interest from Independent Power Producer (IPPs) to invest in solar power.

According to the ZEPTC (2015), like for like capacity, with all the competing technologies, solar has consistently shown to be undesirable. This is mainly due to a high capital cost per KW to plant factor ratio.

There is however a high demand for solar energy systems, especially in remote rural areas where there is no power grid, however the cost is prohibitive. Solar energy can, however be harnessed for pumping drinking water for rural communities, powering lights and appliances at rural institutions (schools and clinics),and water heating in urban areas. Local production of systems is being encouraged by the government to reduce the cost of solar equipment (ZETDC, 2015).

2.3.3 *Electrification (Zimbabwe)*

37 % of households in Zimbabwe have access to electricity that is connected via power lines and in urban areas 83 % of households have electricity, compared with 13 % in rural areas (Ministry of Energy and Power Development; 2012). It is estimated that rural communities meet 94 % of their cooking energy requirements from traditional fuels (mainly firewood) and 20 % of urban households use wood as the main cooking fuel. The majority of urban households use electricity for cooking (73 %), while only 6 % of rural households use electricity (Ministry of Energy and Power Development; 2012).

2.4 PROJECT MOTIVATION

2.4.1 *The Hydropower Potential of the Zambezi Basin*

The Zambezi Basin has considerable potential for hydropower development.

A total capacity of 4,684 MW (about 10 % of the total potential) has been developed in the Zambezi River Basin, of which 75 % is on the Zambezi River itself, producing an average of almost 33,000 GWh per year.

According to estimates, the unused hydropower potential in the Zambezi Basin is 13,000 MW (*Table 2.8*). The table is a long list of possible systems, whose feasibility in terms of water/energy productivity, social, environmental and financial viability varies widely. Several sites have been identified, some at reconnaissance levels, others at pre-feasibility and feasibility level.

The foreseeable future will involve increased development of hydropower in the region to cope with the increased demand for energy in the Zambezi Basin countries, and the SADC region as a whole. However, the full development indicated in *Table 2.8* is unlikely to be realised over the next decades, as more detailed technical, economic and environmental feasibility of the schemes is established. The construction of the Katombora barrage upstream of the Victoria Falls, for example, would regulate the falls, which is a World Heritage site, and is one example of a project that may not be feasible on account of its environmental impacts.

Zimbabwe and Zambia are currently experiencing significant power shortages with Zimbabwe depending unsustainably on load shedding to cover the deficit. Zimbabwe's economy has been significantly affected by power shortages and unreliable power supplies. Both countries are experiencing significant costs of unserved energy. Increased technology penetration and access in all sectors, and the mechanisation of the industrial and the agriculture sectors, is driving rapid demand growth in both countries.

Development and exploitation of Batoka hydropower potential has the following advantages:

- Provides significant capacity and energy to both countries at more competitive energy tariffs than most of the alternative energy sources available to fill in the deficit.
- Unlocks the design operational flexibility at Kariba that is currently limited due to usage of Kariba for base load power production.

Table 2.8 *Hydropower Potential of the Zambezi Basin*

Sub-basin	Power plant/ reservoir	River	Capacity	Mean annual generation		FSL ****	Surface area ****	Annual evaporation	
			(MW)	(GWh)	(%)	(m)	(km²)	(Mm³)	(%)
2	Cahora Bassa II	Zambezi	1,200	6,800	12.6				0.0
	Mepanda Uncua	Zambezi	2,000	10,524	19.5	205	80	174	0.9
	Boroma	Zambezi	444	3,240	6.0	142	30	65	0.3
	Luapata	Zambezi	654	4,960	9.2	125	335	730	3.7
	Ancuaze- Sinjal I	Zambezi	330	2,230	4.1	98			0.0
	Ancuaze- Sinjal II	Zambezi	600	4,460	8.2				0.0
	Chemba	Zambezi	1,040	8,740	16.2	98	1,400	3,052	15.5
	5.8	Revubue	36	155	0.3	600	80	174	0.9
	5.9	Revubue	110	310	0.6	520	8	17	0.1
	5.13	Revubue	85	380	0.7	260	100	218	1.1
	7.6	Lula	257	600	1.1	300	100	218	1.1
	7.11	Capoche	60	250	0.5	440	220	480	2.4
3	Kapichira II	Shire	64		0.0				0.0
	Lower Fufu	S. Rukuru/ N. Rumphi	90	570	1.1	820	0.3	1	0.0
	Songwe	Songwe	150	930	1.7				0.0
	Masigira	N. Ruhuru	118	630	1.2	938			0.0
	Rumakali	Ruhuru	222	1,320	2.4		1.8	3	0.0
		Rumakali			0.0	2,055	13	14	0.1
4	Mpata Gorge	Zambezi	640		0.0		1,190	2,380	12.1
5	Lusiwasi Ext.	Lusiwasi	40	49	0.1		7.5	12	0.1
6	Victoria Falls Ect.	Zambezi	390		0.0				0.0
	Victoria Falls (Zim)	Zambezi	300		0.0				0.0
	Kariba North** Ext.	Zambezi	300		0.0				0.0
	Kariba South*** Ext.	Zambezi	300		0.0				0.0
	Katombora	Zambezi			0.0	940	7,733	10,826	55.1
	Batoka Gorge	Zambezi	1,600	4,700	8.7	770	37.3	56	0.3
	Devil's Gorge	Zambezi	1,240 *		0.0	595	762	1,219	6.2
7	Lower Kafue	Kafue	600	3,000	5.5	582	0.3	1	0.0
	Itezhi- Tehzi	Kafue	80		0.0				0.0
12	1	Lumbage	1	11	0.0				0.0
	2	Zambezi	4	32	0.1				0.0
	3	Zambezi	2	19	0.0				0.0
	4	Luvua	1	10	0.0				0.0
	5	Luizavo	11	100	0.2				0.0
	6	Ludevu	3	26	0.0				0.0
	7	Lumache	1	5	0.0				0.0
	8	Lufuige	2	16	0.0				0.0
	9	Macondo	3	25	0.0				0.0
Total			*12,988*	*54,092*	*100*		*12,098*	*19,640*	*100*

Source: https://energypedia.info/wiki/Zimbabwe_Energy_Situation

The World Bank (2010) report on the multi-sectoral investment opportunity analysis for the Zambezi River basin (1) reports that the coordinated operation of the existing system of hydropower plants in the Zambezi Basin could increase firm energy from 22,776 to 24,397 GWh/year, a gain of 7.1 %. According to the World Bank (2010), the gain from coordinated operation would make it possible to postpone additional capital investment to meet these deficits. The coordinated system could operate at an even higher level of output if more interconnections were available. One such interconnection is under construction between Malawi and Cahora Bassa, but to operate efficiently and share benefits equitably, the whole system should be

(1) The World Bank (2010). The Zambezi River basin: A Multi-sector Investment Opportunities Analysis; Volume 1: Summary report.

interconnected. This viable investment option is a medium-term objective of the SAPP. The estimated benefit from coordinated operation of the existing hydropower system could be as high as $585 million over a 30-year period [1].

2.4.2 *Hydropower and the SAPP Power Expansion Plan*

The Southern African Power Pool presents a Regional Generation and Transmission Expansion Study for the entire SAPP region (Nexant 2007), where a Base Case and an Alternative Case is proposed.

Both cases provide a reasonable set of generating unit additions balanced among peaking, mid-range, and base load units. For the entire SADC Region, the Base Case adds about 39,300 MW with greater emphasis on conventional coal fuelled steam plants.

The Alternative Case instead adds about 36,600 MW with greater emphasis on hydro projects and the transmissions needed to move the power to areas of demand. This Alternative Case over the period up to 2025 envisages development of almost all power plants in the Kariba Sub-basin (No. 6), those in the Shire River/Lake Malawi/Nyasa/Niassa Sub-basin (No. 3), Kafue Sub-basin (No. 7) and the two major power sites (Cahora Bassa II and Mepanda Uncua) in Tete Sub-basin (No. 2); refer to *Table 2.8*. This set of power plants would permit an integrated generation and transmission expansion plan, offering full benefits of power pooling through the region in terms of capacity balance, energy balance, system reliability and economies in investment costs and operation and maintenance.

By adopting this development package as the total expansion of the hydropower system, the total power development is estimated at approximately 53 % (6,616 MW) of the total hydropower potential of the Zambezi Basin, and only about 1 % (249 Mm^3) of the annual evaporation. The SAPP power expansion plan, in addition, envisages development of 24 MW of small hydro per year over the period 2006 – 2025.

2.4.3 *The Batoka Gorge Hydropower Project in Relation to the SAPP Power Expansion Plan*

As far as hydropower development in the Zambezi Basin is concerned, the difference between the SAPP Base Case and the Alternative Case is mainly in the timing of the construction of the Batoka HES. The total additional installed capacity at Batoka Gorge would be in both cases between 1,600 – 3000 MW. The Kariba extensions will only provide peaking power and reserve capacity; they will not increase overall firm energy before the construction of the Batoka Gorge dam. The 750 MW Lower Kafue Gorge scheme and the 1,600 - 3000 MW Batoka George Project can make a substantial contribution to power supply.

(1) The World Bank (2010). The Zambezi River basin: A Multi-sector Investment Opportunities Analysis; Volume 1: Summary report.

2.4.4 The Batoka Gorge Hydropower Project and Energy Security in Both Zambia and Zimbabwe

Despite Zambia and Zimbabwe's vast renewable and non-renewable energy sources, little of these have been utilised to improve the attractiveness of the energy sector and transfer the benefits for industrial expansion, employment creation and poverty reduction in both countries. The energy market structure and consumption shows that traditional wood fuels (biomass), such as firewood and charcoal sourced from natural woodlands and agricultural lands dominate the energy market.

Investment in energy is a prerequisite to achieving commercial and industrial development in Zambia and Zimbabwe. The use of solar power is favourable in providing rural and urban areas with access to power; however, if both countries are to achieve those targets and goals detailed in their Vision 2030 and Vision 2040, and other complimentary plans (such as the System Development Plans), these countries will require private sector investment in energy technology that is efficient, sustainable and reliable. The generation of energy through hydropower is a proven technology that is sustainable and which is actively being promoted at a national level in both Zambia and Zimbabwe. With a vast hydropower energy potential, hydropower is considered the most feasible and reasonable electrification option for both countries.

Preliminary investigations, geographical exploration as well as the 1993 and 1998 ESIA studies have concluded that the Batoka HES project with a proposed installed capacity of 1,600 MW is the least cost solution and has the least adverse environmental impacts. The site for the proposed scheme has been chosen as the most viable compared to the other sites investigated (*Chapter 8* of this Report) and has been ranked as the first major hydro-electric development on the Zambezi River since the construction of the Kariba Dam (IUCN, 1992).

The objective of the Batoka HES is to increase power generation capacity in both Zambia and Zimbabwe, reduce power outages and reduce reliance on coal fired power stations. Once completed, the Batoka HES project will contribute significantly to the electricity supply of both countries, and also serve to distribute power to southern African countries, thanks to several planned projects under the coordination of the Southern African Power Pool (SAPP) aimed at increasing transfer limits through boundary connections.