PROJECT INFORMATION DOCUMENT (PID)
CONCEPT STAGE

Report No.: PIDC2429

Project Name	Kariba Dam Rehabilitation Project (P146515)
Region	AFRICA
Country	Zambia
Sector(s)	Hydropower (60%), Flood protection (20%), General water, sanitation and flood protection sector (20%)
Theme(s)	Water resource management (60%), Natural disaster management (40%)
Lending Instrument	Investment Project Financing
Project ID	P146515
Borrower(s)	Government of the Republic of Zambia
Implementing Agency	Zambezi River Authority
Environmental Category	A-Full Assessment
Date PID Prepared/ Updated	12-Dec-2013
Date PID Approved/ Disclosed	26-Dec-2013
Estimated Date of Appraisal Completion	
Estimated Date of Board Approval	28-Aug-2014
Concept Review Decision	Track II - The review did authorize the preparation to continue

I. Introduction and Context

Country Context

The southern African region has experienced sustained economic growth and increasing prosperity over the past decade. The annual rate of GDP growth in 2011 averaged around 5.14%, with GDP for the region estimated at around US$575.5 billion. This has been largely driven by increasing demand for natural resource based commodities facilitated by increased peace and stability. With the population of the Southern African Development Community (SADC) region expected to more than double from around 280 million people in 2012 to more than 560 million over the next 30 years, and as the SADC region industrializes on its path to improved human development, the demand for power is likely to increase by 40 percent over the next decade. The electricity sector is seen as central to catalyzing infrastructure projects that drive both regional integration and economic growth, and energy security will continue to be increasingly important to continued development across southern Africa.

Recognizing the importance of the energy sector to regional growth prospects, the SADC has developed and implemented a comprehensive framework to facilitate integration, with energy playing a central role through the Southern African Power Pool (SAPP). The SAPP was established in 1995 to provide a forum for regional solutions to electricity generation and provides for coordinated planning and operation of the regional power system. The current operations of the SAPP build on a concerted effort to establish a regional framework for energy security based on several regional strategic plans for energy development: the SADC Energy Cooperation Policy and Strategy in 1996, the SADC Energy Action Plan in 1997, the SADC Energy Activity Plan in 2000, and most recently the Regional Infrastructure Development Master Plan and its Energy Sector Plan in 2012. These development strategies set out specific objectives for SADC and its Member States for infrastructure development in energy and its subsectors, with the Energy Sector Plan and RIDMP defining the regional infrastructure requirements and conditions to facilitate the realization of key infrastructure by 2027.

The long-term growth prospects and security of the SAPP are heavily dependent upon availability of the hydropower resources of the Zambezi River basin. Hydropower remains an important but under-represented contributor to the SAPP, accounting for 17% (9,474 MW) of the overall generation capacity. The Zambezi River basin accounts for roughly 50% of this, with close to 5,000 MW of installed capacity and a similar amount planned for further development. In addition to the provision of firm energy, the centrality of the Zambezi River basin within the SAPP means that the hydropower schemes provide an important balancing element in the overall regional energy mix. Securing these resources is therefore critical to ensuring regional energy security and stability, and avoiding the regional blackouts that have undermined growth prospects in recent years as demand exceeds supply.

The peak demand of the SAPP was 45,315 MW in 2012 against an available capacity of 49,877 MW. Considering a 10.2% reserve requirement this is equivalent to a 173 MW shortfall for the interconnected system and 60 MW for the southern African region. Aging infrastructure, decommissioning of some plants and limited investments in new generation has reduced the available capacity leading to a regional supply deficit between 2007 and 2012/13 manifest through rolling regional blackouts. In Zimbabwe, energy demand is estimated at over 2,000 MW with installed generation capacity approximately 1,960MW, of which only around 1,200MW is presently available for production. The result is a significant supply/demand gap of around 700MW, rising to 1,000MW during the winter season. There is also extensive suppressed energy demand that further dampens recovery and growth. In Zambia, demand is projected to increase from 1,600 MW in 2010 to about 2,400 MW in 2020. Investment needs in generation alone to provide required supply is estimated to be about US$6 billion in the next 10 years.

Sectoral and Institutional Context

The Kariba Dam and Hydro-Electric Scheme (HES), constructed across the Zambezi River between 1956 and 1959, is the second largest hydro-electric scheme in the ZRB after the Cahora Bassa complex situated downstream in Mozambique. A double curvature concrete arch dam, standing at 128 m tall with a developed crest length of 617 m and a reservoir capacity of 181 km3, it is one of the largest in the world. The spillway comprises six submerged flood sluices located in the central part of the dam wall, with a lower level of +455.37 m (Kariba Datum). The minimum operating level of the reservoir is +475.5 m. The maximum discharge capacity of the spillway is approximately 9,000 m3/s. The highest recorded discharge from the dam for flood control was 7,300 m3/s in 1978 (combined outflow through four gates fully open,and power stations). The

active storage at the Full Supply Level of +488.5m is 64.5 km3. This includes 23.2 km3 of flood control capacity that has to be made available at the beginning of each flood season (February to April) for flood attenuation.

Given the large the reservoir capacity (181 km3) a dam failure would result in a catastrophic disaster downstream in the Zambezi River. Such an event would seriously affect the Cahora Bassa Dam, resulting in regional power shortages and devastating flooding of low lying areas in Mozambique and Malawi. The largest ever flood on record was estimated at 61km3 over 90 days in 1958/59. A catastrophic failure of the Kariba Dam would likely result in a flood four times larger than this, with the combined storage of the Kariba and Cahora Bassa reservoirs equal to 237km3 (Kariba: 185km3 & Cahora Bassa: 52km3). This would result in loss of 40% of the SAPP generation capacity (excluding RSA), with 1,320 MW at Kariba and 2,075 MW at Cahora Bassa. The 2001 floods (January through April) resulted in more than US$40m in damages, the displacement of an estimated 500,000 people and estimated 150 fatalities, with around 100,000 ha flooded.

The Kariba HES has been central to energy security and economic development in both Zambia and Zimbabwe, and has an important role in ensuring the stability of the SAPP and in regulating flows on the Zambezi River. The reservoir supplies water to two underground hydropower stations located on the North (left) bank in Zambia and on the South (right) bank in Zimbabwe. The two power stations were constructed with a combined capacity of 1,200 MW, later upgraded to 1,226 MW and more recently increased to 1,470 MW, generating 6,400 GWh per annum. Based on the average tariffs in Zambia, this corresponds to revenues of roughly US$385 million per year. Each country has its own power station operated by the respective national power utility. The Kariba South Bank Power Station was commissioned in 1960 with six turbines that have been uprated over the years to have a current capacity of 720 MW and is operated by ZPC. The Kariba North Bank Power Station was built and commissioned between 1975 and 1977 with four turbines uprated over the years to provide 750 MW and is operated by ZESCO, the vertically integrated, utility in Zambia.

After 50 years of operation serving the southern African region, the Kariba Dam now requires a series of rehabilitation works for its continued safe operation. A failure to invest in the timely rehabilitation of the dam will result in the gradual degradation of key safety features associated with the structure to a level that is not acceptable in accordance to international standards. These works include: 1. (a) the design, fabrication and installation of an emergency gate and a new gantry to prevent uncontrolled loss of water in the event of floodgate failure, which would result in water levels dropping below the minimum operating levels and interrupting power production; (b) the refurbishment of the upstream stop-beam guides and replacement of secondary concrete to prevent failure during operation of stop-beams and, 2. reshaping of the plunge pool downstream of the dam to limit scouring and erosion that could potentially undermine the dam foundations, leading to dam failure.

Relationship to CAS

The World Bank has had a long-standing commitment to global priorities and region-wide programs. The 2008 Regional Integration Strategy for Africa provides a coherent and strategically focused framework to guide the Bank Group’s assistance in support of regional integration and regional programs in the provision of regional public goods. The strategy acknowledges that regional approaches to the management of shared waters can provide improved water security and more sustainable management of these resources than is achievable through national action alone. It

further recognizes that effective management is all the more urgent given the potentially disruptive impact of climate change on water resources availability and increasing water demand resulting in potential conflicts arising from limited supplies. The strategy specifically focuses Bank engagement around three key pillars, which includes coordinated investments in support of regional public goods focusing on shared water resources, climate change, and emergency response, among others.

The proposed project is aligned with the Bank's program of support to sustainable economic development and sustainable management of the resources in the Zambezi River basin. This includes support to the Zambezi Watercourse Commission (ZAMCOM) to advance its efforts to promote the equitable and reasonable utilization of the water resources of the Zambezi watercourse as well as the efficient management and sustainable development thereof. Within this context, the multi-donor trust fund for Cooperation in International Waters in Africa (CIWA) is also supporting the ZRA to advance the development of the Batoka Gorge hydro-electric scheme and support institutional cooperation through policy harmonization.

The project is aligned with prioritized activities outlined in the ZRA Strategic Plan adopted by Zambia and Zimbabwe, as well as the national development strategies of both countries. The strategic plan acknowledges the need to implement critical dam maintenance programs in order to minimize the risk of catastrophic failure of the dam. These have been advanced through ZRA's own resources with the completion of feasibility studies and an independent expert review. The ZRA Strategic Plan and the national development strategies all recognize that a secure and reliable supply of electricity is essential for accelerating and diversifying growth as well as enhancing economic development. The strategic focus of the energy sector provisions recognizes the need to invest in critical rehabilitation programs to secure existing assets along with investment in new generation capacity to ensure that an adequate and reliable supply of energy is made available to support the development processes in growth sectors of the economy.

The proposed project is directly linked to the development objectives under the Country Partnership Strategy for Zambia FY13-16 (Report No: 75089-ZM). The CPS recognizes that both energy and water resource development have public good aspects to them with positive implications for Zambia's development in the long-run and CPS Outcome 2.2: specifically focusses on infrastructure rehabilitation. The CPS acknowledges the role of the Bank in supporting the ZRA in facilitating the financing and rehabilitation options for the Kariba dam and further development of the Batoka Gorge Hydro-Electric Scheme. Within this context, the proposed support would also make a significant contribution to the partnership models envisaged under the Interim Strategy Note FY13-15 for Zimbabwe approved in March 2013 (Report No. 74226-ZW) and help strengthen operational readiness to re-engage with Zimbabwe.

A letter of request was received on June 12, 2013 from the Ministers of Finance of Zambia and Zimbabwe requesting support from the Wo rld Bank to assist the Zambezi River Authority (ZRA) in exploring viable options for financing and raising resources for the rehabilitation of the Kariba Dam.

II. Proposed Development Objective(s)

Proposed Development Objective(s) (From PCN)

The proposed Project Development Objective is to assist the Zambezi River Authority in securing the long-term safety and reliability of the Kariba Dam Hydro-Electric Scheme.

Key Results (From PCN)

Progress toward achieving the project outcomes will be measured by the following indicators:
i. Development and implementation of a financing plan
ii. Successful reshaping of the plunge pool and dissipation of energy
iii. Successful installation of sluice gatesand enhanced operational control over reservoir releases

III. Preliminary Description

Concept Description

The proposed project will assist ZRA in financing implementation of two critical components for the rehabilitation of the Kariba Dam.

Component 1: Stabilization of the Kariba Dam Plunge Pool. This includes an estimated US$80m for reshaping and stabilization of the plunge pool. The ZRA commissioned consultants who completed a series of feasibility and design studies in July 2012 estimating the cost of the works at around US $50m, excluding required advanced infrastructure (access roads etc.), tendering, supervision and engineering costs, along with the owners own costs, provisional sums or escalations from 2012. These works are required to prevent further scour along the weak fault zone towards the dam foundations.

An 80m deep scour hole has formed in the bedrock immediately downstream of the dam foundations over the past 50 years. This work is unprecedented in dam history and urgently needed to prevent any potential further regression and protect the dam from catastrophic failure due to lack of foundation support. The measures are required to reshape the plunge pool through excavation of the downstream face and north and south bank sides of the pool. An estimated volume of 300,000 m3 of rock is required to be excavated from the plunge pool resulting in a stepped profile to increase the energy dissipation and guide the spilling water in the downstream direction, away from the dam foundations. A 3D FEM model has been established to assess how the plunge pool scouring progress and excavation works would affect the stress field of the dam foundation. Further geological investigations may also be required during work preparation and execution period.

This component would support: (i) technical assistance to ZRA in procurement for the works associated with reshaping of the plunge pool, through either design-build contract or preparation and supervision of detailed bidding documents; (ii) works associated with the reshaping of the plunge pool; (iii) environmental and social mitigation activities; and, (iv) strengthening the project implementation team for effective project monitoring and implementation. This will be supported through the provision of: i) Consulting Services; ii) Civil Works; (iii) Goods, Equipment and Non-Consulting Services; along with (iv) Operating expenses.

Component 2: Rehabilitation of the Spillway Up-stream Hydro-mechanical Facility. The ZRA completed a series of feasibility and design studies in July 2012 estimating the cost of the works at around US$120m for capital expenditures related to the design, fabrication and installation of an emergency gate and a new gantry, with refurbishment of associated civil works, including replacement of secondary concrete and stopbeam built-in-parts, to prevent failure of the upstream spillway control facility. This excludes any advanced infrastructure, tendering, supervision and engineering costs, along with the owners own costs, provisional sums or escalations from 2012.

The studies conducted by ZRA highlight concerns over the limited function of the upstream stop beam-facility due to the advanced deterioration of the secondary concrete in the guide slots, and inability to lower the stop-beams for closing a sluice in the event of a downstream flood gate failure. This means that there is no way to stop water flow if the downstream flood gate is jammed and cannot be closed. The water level in such a case may go down to the sill of the spillway at +455.37 meters, well below the minimum operating level before the gates can be repaired. Thereafter, it may take more than a year to restore the water level to the minimum operational level, corresponding to the live storage volume of 41.3 km3, given that the annual runoff volume ranges between 15-94 km3/year. During this period no power production would be possible at either the Zambian or Zimbabwean power stations.

There is also a possibility that the gate could be jammed in the middle position and cannot be fully opened when required during large floods. The swelling effect of alkaline aggregate reaction (AAR) in the dam concrete has resulted in distortions of the stop-beam guides, causing periodic jamming of the stop-beams during operations. The AAR has also reduced the tolerances for gate movements making gate operation increasingly difficult. The support would include plans to upgrade the current stop beams (composed of six pieces) to a flexible roller gate which has independent opening/closing function for the upstream sluice opening irrespective of downstream gate position/flow condition. The existing gantry crane also needs to be replaced with higher capacity gantry in order to operate the new emergency gate under water flowing conditions.

The operation of the flood gates is also constrained by the plunge pool condition. The operator can currently open only a maximum of three out of six gates due to excessive scouring and erosion of the plunge pool over 50 years of operation. This has the effect of needing a low ering of the operation rule curve of the reservoir, thus reducing the water available for power generation. The delay in commissioning of the north bank power station further contributed to more spilling and unanticipated deepening of the plunge pool. Continued spilling will cause the progression of scouring towards the dam toe area affecting the foundation rock supporting the dam. An empirical formula based simulation, (numerical and physical modeling) has been established to allow comparison with survey results to better understand the scouring phenomena and predict the progression and the intervention measures required to arrest the scouring.

This component will support: (i) technical assistance to ZRA for either a design-build contract or preparation and supervision of detailed bidding documents for the sluice gates; (ii) works required for rehabilitation of the sluice gates; (iii) environmental and social mitigation activities; (iv) strengthening of the project implementation team for effective project monitoring and implementation. This will be supported through the provision of: i) Consulting Services; ii) Civil Works; (iii) Goods, Equipment and Non-Consulting Services; along with (iv) Operating expenses.

Project Cost and Financing

The cost of the Kariba Dam Rehabilitation Program is estimated at around US$200 million. This is based on a series of feasibility and design studies completed in July 2012 by consultants appointed by the Zambezi River Authority. These initial estimates were subject to an independent review by an expert panel in 2013 and have been escalated to account for possible advanced infrastructure, tendering, supervision and engineering costs, along with the owners' own costs, provisional sums and escalations from 2012.

The ZRA is a financially autonomous organization that generates operating revenue through water tariffs charged to the power utilities for water consumed in the generation of electricity. The formula used is intended to provide the ZRA with sufficient revenues to carry out the mandated functions, including operation and general maintenance but not to generate profits or finance major rehabilitation works. The current tariff structure includes two-parts, with a fixed monthly element supplemented by a volumetric charge billed monthly. The formula is reviewed every three years with tariffs adjusted annually according to the CPI rate of the United States. The ZRA has experienced a steady supply from 2007 to 2011, averaging around 35,000 MCM in the past 10 years. Tariffs have increased roughly 10% per annum from 2008 to 2011, with average annual revenues of around US$10 to 12m per year. A preliminary financial model has been developed and preparation would support a more detailed analysis to provide an indication of:

(i) ZRA's current assets and liabilities, including cash flows available to service debt;
(ii) ZRA's ability to take on further debt and at what cost;
(iii) the impact of additional debt to ZRA's tariff structure; and
(iv) optimal tenor and margins ZRA should consider when seeking any debt.

A preliminary financial analysis indicates that concessional resources less than 3-5% could be repaid by the Zambezi River Authority within a 10 year grace period without any increase in the current tariff regime. Any non-concessional resources would require an increase in the current water tariff regime charged by the ZRA which would have a pass through effect on the electricity sector tariffs. Any such non-concessional resources would further require a substantial equity injection in order to be financially sustainable under ZRAs current financing framework.

The Governments of Zambia and Zimbabwe have formally written to request support from the Bank in exploring viable options for financing and raising resources for the Kariba Dam Rehabilitation Program. Given that the Government of Zimbabwe is currently limited in its access to concessional financing until settlement of outstanding arrears to the multi-lateral development banks, it will defer the full cost to Zambia.

The proposed project is intended to be processed as one in a Series of Projects envisaged as part of a program of support to the riparian states and regional bodies in the Zambezi River basin in accordance with Investment Project Financing OP/BP 10.00. The Series of Projects is being supported through the multi-donor trust fund for Cooperation in International Waters in Africa (CIWA MDTF), complimenting an existing portfolio and pipeline of IDA projects among the eight riparian states within the Zambezi River basin over a 10 to 15 year period. The projects are intended to provide a broad program of support in response to the common development goals of the riparian states and regional organizations relating to the integrated development and management of water resources in the Zambezi River basin.

An allocation of US$25 million has been earmarked from Zambia's national IDA envelope for the proposed project. The African Development Bank has indicated an interest to co-finance a portion equal to the IDA contribution and the European Union has submitted an application to the 11th European Development Fund for an estimated €50 to 70 million (~US$70-100m).

Regional concessional funds could be used to leverage the national contribution from Zambia and close the financing gap. The project meets IDA's regional eligibility criteria in that it provides

specific investments that have important regional as well as national social and economic benefits for the eight riparian states as well as the members of the Southern African Power Pool.

IV. Safeguard Policies that might apply

Safeguard Policies Triggered by the Project	Yes	No	TBD
Environmental Assessment OP/BP 4.01	x		
Natural Habitats OP/BP 4.04		x	
Forests OP/BP 4.36		x	
Pest Management OP 4.09		x	
Physical Cultural Resources OP/BP 4.11	x		
Indigenous Peoples OP/BP 4.10		x	
Involuntary Resettlement OP/BP 4.12			x
Safety of Dams OP/BP 4.37	x		
Projects on International Waterways OP/BP 7.50	x		
Projects in Disputed Areas OP/BP 7.60		x	

V. Financing (in USD Million)

Total Project Cost:	200.00	Total Bank Financing:	25.00
Financing Gap:	175.00		

Financing Source	Amount
BORROWER/RECIPIENT	0.00
International Development Association (IDA)	25.00
Total	25.00

VI. Contact point

World Bank

Contact: Marcus J. Wishart
Title: Sr Water Resources Spec.
Tel: 5369+3147
Email: mwishart@worldbank.org

Borrower/Client/Recipient

Name: Government of the Republic of Zambia
Contact:
Title:
Tel:
Email:

Implementing Agencies

Name: Zambezi River Authority
Contact:

Title:
Tel: +260 211 228401/02
Email: zaraho@coppernet.zm

VII. For more information contact:

The InfoShop
The World Bank
1818 H Street, NW
Washington, D.C. 20433
Telephone: (202) 458-4500
Fax: (202) 522-1500
Web: http://www.worldbank.org/infoshop

Public Disclosure Copy