Terms of Reference

Engineering Proposal – Solar Option
Inter-Basin Water Transfer to Lake Chad
Prepared for the
Lake Chad Basin Commission

Consultant: Guy Immega, P.Eng. ret.
Vancouver, BC, Canada
guy.immega@kinetic.ca

Introduction:

A previous feasibility study to restore Lake Chad was completed by CIMA in 2011. In broad terms, the study recommended a 360 MW hydroelectric dam on the Ubangi River in the Congo River Basin. Most of the power from this dam would be used to pump water to Lake Chad.

A dam on the Ubangi River would flood the waterway 200 km upstream, displacing villages and disrupting fishing and navigation. A major concern was the possibility of reduced water flow to the planned Inga hydroelectric facilities in the Democratic Republic of Congo.

The new proposal will consider the option of using solar energy to pump water from submerged intakes during periods of high water in the Ubangi River. This approach avoids the environmental impacts of a dam and is based on renewable solar energy. Pumping will occur during daylight hours only, when solar energy is available. Surplus solar power will be distributed to nearby towns and villages.

Although these Terms of Reference use information from the previous CIMA 2011 feasibility study, and also from the 1970-2014 Bonifica Transaqua proposals, the current concept for IBWT (Inter-basin Water Transfer) using solar energy (the Solar Option) is intended to have low environmental impact, reduced cost, and use sustainable renewable solar energy.

The scope of these Terms of Reference includes all the engineering information necessary for completion of IBWT to Lake Chad. This includes technology specifications and sources, infrastructure required (such as roads), milestone goals and schedules for staged construction, and budget. Appendix 1 specifies a Sustainable Agriculture Study for the Lake Chad Basin.

Glossary:

CAR – Central African Republic
CIMA – CIMA International, engineering company in Laval, Quebec (previous study)
DRC – Democratic Republic of Congo
Green Grid – intermittent electrical power distribution from renewable energy sources
IBWT – Inter-Basin Water Transfer (from the Congo Basin to the Lake Chad Basin)
LCBC – Lake Chad Basin Commission
PV – photovoltaic technology (solar-electric panels)
Solar Option – the use of solar power (instead of hydroelectric) to pump water to Lake Chad

1. Solar Power

    1.1. Photovoltaic Power:
    This project will be powered by PV technology (no dams or flooding). The optimum size of the PV power station shall be calculated (an example is the 290 MW Agua Caliente Solar Project in Arizona). Specific PV technology will be selected, based on cost, reliability, maintenance requirements, and projected lifetime. The PV power station shall initially produce electricity in daytime only; the design must accommodate future upgrades (such as grid-scale energy storage and other power sources) to standard 24-hour service.

    1.2. Staged Construction:
    A staged construction plan for the PV power station shall be considered. Early startup of PV power may enable pumping sooner. If and when grid-scale energy storage technology becomes available, allowing nighttime pumping, this may affect the size of the PV Power Station.

    1.3. PV Power Station Site:
    Recommended siting for the PV Power Station (central and/or distributed) shall be determined. Considerations will include insolation (amount of sunlight available), road access, installation costs, transmission line route, operator personnel needed, and maintenance requirements.

    1.4. Green Grid Transmission Line:
    Initially, electrical power transmission from the PV Power Station to the pumps will be during daylight hours only. However provision shall be made for future grid-scale energy storage technologies to extend power delivery into evening hours. Eventually, the Green Grid will be connected to other power grids, proving continuous power. The optimal transmission line route shall be determined. Voltage, pylons vs. ground level, and power conditioning technology shall be specified. Provision for surplus electric power distribution to nearby towns and villages shall be addressed.

2. Pumping Water from the Ubangi River

    2.1. Water Usage from the Ubangi River:
    Monthly seasonal flow estimates, average and peak, shall be provided, along with amounts of water available each month for daytime pumping to Lake Chad. The goal is to pump only surplus flow from the Ubangi River, while leaving the minimum flows unchanged (i.e. pumping will cease during low water periods). [NB: The amounts of water taken from the Ubangi River shall have negligible impacts on the power potential of future development of the Inga hydroelectric dams on Congo River—i.e. water pumped to Lake Chad would otherwise flow as unused surplus over the spillways of the Inga dams.]

    2.2. Impact of Pumped Water on Lake Chad
    Based on pumped volume estimates, the change in volume and level of Lake Chad shall be calculated over time (including diversions of water for irrigation and local water use). Three scenarios shall be analyzed for project size, staged construction time, pumping

time, and cost:
- Level 1: enough water for irrigation of agricultural crops in the Lake Chad Basin;
- Level 2: enough water to restore Lake Chad fisheries and pastureland;
- Level 3: enough water to restore the natural ecosystem of Lake Chad.

2.3. Pumping Site Location:
Previous engineering studies have identified the Palambo site on the Ubangi River for a hydroelectric dam. The advantage of the site is the Ubangi River is narrow, reducing the cost of dam construction. However, since the Solar Option avoids the use of a dam, the Palambo site will be left available to the DRC/CAR for a future dam. The study shall specify the pumping site location upstream from Palambo, with the objective of minimizing the length of pipes needed to transport water under pressure.

2.4. Submerged Water Intakes:
In order to avoid flooding of the Ubangi River, submerged water intakes shall be used. The study shall provide the specification and design of the submerged water intakes. The intakes may be in the Ubangi River or in a constructed diversion. The intake design shall consider means to minimize silting, scouring, exposure during low water flows, and the impacts of flooding. Riverbank infrastructure, connection to pumps, maintenance requirements and procedures shall be specified. Fish screens and/or other technologies (e.g. electric fish barriers) on the intakes shall be considered. Submerged intakes shall not adversely impact navigation on the Ubangi River.

2.5. Pumping Requirements:
Based on the volume amounts of Ubangi River water available for daytime pumping, the type, size, efficiency, and power of pumps shall be determined. The pumps may be integrated with submerged water intakes or in a separate location. Multiple, parallel pumping stations will allow variable amounts of water to be pumped, according to the volume of surplus water available. Pumping power requirements must match seasonal availability of PV power.

2.6. Pipelines & Canals:
The previous CIMA Feasibility Study specified a pipeline and canal route across the CAR, eventually reaching the Chari River in Chad. The CIMA study specified three conduits of 6 meters in diameter for pumped water from Palambo site on the Ubangi River; this specification shall be reviewed for practicality. More pipelines, and/or smaller pipelines, may provide a better match to the submerged intakes.

The CIMA pumped pipeline route followed the bed of the Tomi River up to the interbasin crest, where a trench would make it possible to reach the Lake Chad basin. Canals and works on the Tomi, Fafa, Ouham and Chari rivers would convey the water by gravity to Lake Chad. The new feasibility study of the Solar Option will re-examine the CIMA pipeline and canal routes, with a view to minimizing distance and costs. Impediments shall be identified, including physical, geographical and infrastructure conflicts (e.g. roads, railways, etc.). The study will identify measures to overcome difficult terrain.

2.7. Kotto River:

The CIMA study also specified a second water source for Lake Chad from the Bria Dam on the Kotto River (in the Eastern CAR near South Sudan). Since the Solar Option obviates the need for dams, the Bria Dam will not be considered. However, the feasibility study will examine the Kotto River as a seasonal water source for Lake Chad. Gravity flow from the Kotto River may, or may not, be practical.

2.8. Maintenance, Lifetime & Security

Since the solar powered pumps, pipelines and canals to replenish Lake Chad will be installed in remote regions of the CAR, low maintenance is an important issue. Estimates of numbers and types of skilled workers needed to keep IBWT working shall be provided. Possible trade-offs between technology upgrades, project cost, maintenance costs, and project lifetime shall be considered. Finally, since the pipeline, canal and transmission line routes go through regions of political instability and civil unrest, sabotage, water theft and security monitoring shall be considered.

2.9. Environmental Impact Assessment

• Cross-contamination of Species

Water transfer from the Ubangi River creates the risk of Congo Basin river species being introduced to Lake Chad. Other water transfer schemes have addressed this problem, such as fish screens (as used for hydroelectric power plants) or the electric fish barrier in the Chicago Sanitary and Ship Canal. The new study will assess risks and recommend specific counter-measures.

• Migration and Animal Crossings

Construction of pipelines, canals and transmission lines that across hundreds of kilometers will interfere with local animal movements. Animal crossings (bridges, tunnels) and other mitigation technologies shall be considered.

• Construction Impacts

Construction of pipelines, canals and roads my adversely effect sensitive environmental sites, such as riverbanks. These shall be identified along with recommended mitigation measures.

• Environmental Benefits

Use of Green Grid electricity for cooking can reduce fuel-wood consumption, promoting reforestation (green wall).

2.10. Social and Economic Benefits

The engineering study shall include a summary of the project's direct and indirect social and economic benefits. Estimates of economic benefits shall be divided into three categories: infusion of financial support, employment during construction, and long term infrastructure upgrades (including roads, water for villages and rural electrification). [NB: Additional long term social and economic benefits—including agriculture and food security, increased employment opportunities and wealth generation—will arise from an expanded sustainable agriculture industry for the peoples of the LCBC countries.]

2.11. National and Cross-Border Issues

International cooperation is needed for IBWT from the Ubangi River to Lake Chad. Since the Ubangi River forms the border between DRC and CAR, removal of water may impact both countries. However, no infrastructure is required in the territory of the DRC.

Water from the Ubangi River will cross the CAR and enter the Chad Basin on one or more tributaries of the Chari River; the location(s) for this border crossing shall be determined and any engineering and environmental issues identified. After crossing from the CAR into Chad, water will enlarge the upper flows of the Chari River, with potential environmental impacts; any water works needed on tributaries to the Chari River, and on the Chari River itself, such as bank stabilization and dredging, shall be identified.

3. Comprehensive Budget & Schedule for Construction of the Solar Option

APPENDIX 1.

Sustainable Agriculture Study – Lake Chad Basin

[NB: This study is intended to complement to the IBWT study.]

Introduction

The purpose restoring Lake Chad is to provide for a massive increase in agriculture. Irrigation of the hot, dry soils of the Sahel will allow high productivity in the Lake Chad Basin without pests or fungal blights.

A wide variety of crops can be cultivated. Paddy rice may grow in swampy areas. Other high-yield serial crops—maize (corn), wheat, wheat barley, sorghum, and millet—can be grown in progressively dryer areas. These cereal crops provide basic carbohydrates. Orange sweet potato can provide both carbohydrates and good source of Vitamin A.

High value crops for export include fruits and vegetables, such as mangos and tomatoes. In addition, ocra, melons, cassava, and cowpeas provide nutrition. These crops require intensive cultivation, providing employment for large numbers of agricultural workers.

Forage corridors for cattle, goat and camels are important. These can be near canals feeding the lake, or near Lake Chad itself.

Maximize Crop Production – Food Security for sub-Saharan Africa

• Recommended Crops by Percentage
  - cereal crops
  - legumes
  - fruits
  - vegetables
  - animal forage & feed
  - fuelwood

• Soil Remediation
  - Tillage
  - Fertilizers Required
  - Brine Disposal
  - Diversion of fertilizer and pesticide runoff from lake waters

• Land Use Allocation
  - Ownership of Newly Created Agricultural Land
  - Multinational Cross-Border Issues
  - Crop Segmentation
  - Livestock Forage Areas
  - Fisheries Management
  - Reforestation

• Cultivation Technologies

- Traditional Subsistence Farming
- Large Scale Industrial Agriculture
- Advanced Sustainable Agriculture
- Water Conservation & Open-Air Hydroponics
- Food Productivity Goals

• Infrastructure Improvements Needed
- Electrical Power Grid
- Roads & Waterborne Transport
- Crop Storage & Distribution
- Electric Farm Machinery
- Banking & Lending for Farmers
- Housing & Medical for Agricultural Workers

• Employment in Agricultural Sector

• Budget & Schedule for Agricultural Study