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Network Studies and 2023 – 2040 Continental Transmission Expansion Plan

The Continental Power System Masterplan (CMP) was initiated in 2019, following a decision of the African Energy Ministers to serve as a blueprint for the African Single Electricity Market (AfSEM).

The integrated planning scenarios, developed with support from the European Union - Global Technical Assistance Facility (EU-GTAF), provide an outline of credible pathways of how the electricity sector in Africa will evolve in the next 20 years, considering the unique challenges and aspirations of each of Africa's five regions and guided by the continental aspirations espoused in the AU Agenda 2063 Goals.

The synergy and complementarity of the AfSEM and CMP assignments will ensure that efficient generation facilities and resilient electricity interconnections will support adequate and efficient market-based mechanisms for trading.

OBJECTIVE

This deliverable aims to:

- Develop future regional and continental network models from the existing models to enable the analysis of Africa's interconnected transmission networks at both regional and continental levels that will form the basis for the AfSEM;
- Assess the optimised interconnector capacities to confirm if the transfer capacities derived in the SPLAT-Africa model are technically feasible;
- Determine the in-country backbone transmission strengthening and reactive power compensation required to facilitate the exchange in the optimised interconnector capacities; and
- Determine the continent's CMP baseline medium-term [2023-2030] and long-term [2031-2040] transmission expansion plan.

METHODOLOGY

- Preparation of the study assumptions and technical assessment criteria
- Analysis of the existing regional interconnected transmission systems
- Preparation of the future regional and continental PSS®E network models
- Assessment of the integrated regional and continental PSS®E network models
- Derivation of the medium-term (2023-2030) and long-term (2031-2040) continental transmission expansion plan

Continental transmission assessment results

YEAR 2025 ASSESSMENT

By 2025, it is expected that the CAPP, COMELEC, EAPP and SAPP electricity grids will be interconnected, albeit mostly through weak transmission interconnections.

Existing inter-regional interconnectors include the DRC – Rwanda 110kV line, DRC – Rwanda/Burundi 70 kV lines (CAPP - EAPP), DRC - Zambia 3 x 220 kV lines (SAPP - CAPP), Egypt - Libya 220 kV line (EAPP - COMELEC), Egypt – Jordan 400 kV subsea cable and Morocco – Spain 2 x 400 kV subsea cables.

The following inter-regional interconnectors are also expected by 2025:

- Tanzania (Mbeya) – Zambia (Nakonde) 400 kV line [100 km]
- Egypt (Badr) – Saudi Arabia (Medina/Tabuk) 500 kV HVDC link [1,350 km lines and 22 km subsea cables]
- Angola (Lubango/Cahama) – Namibia (Kunene) 400 kV line [366 km]

YEAR 2030 ASSESSMENT

By 2030, it is envisaged that the CAPP - WAPP regions will not yet be interconnected.
Interconnections between CAPP, SAPP, EAPP and COMELEC indicate that by 2030 a strong coordination among these regions and the interconnected countries will be required.

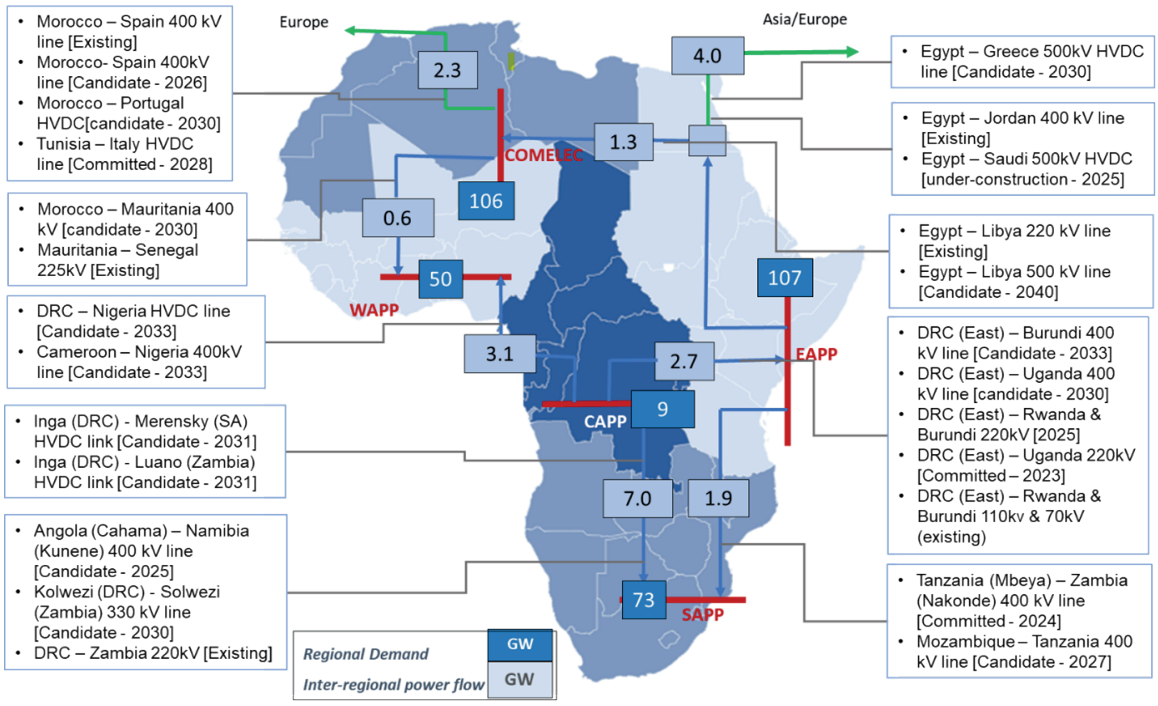
YEAR 2040 ASSESSMENT

By 2040, all five regional power pools are expected to be interconnected, with CAPP interconnecting to SAPP, EAPP and WAPP. The Nigeria (WAPP) – Cameroon (CAPP) 400 kV interconnector is expected by 2033, and when commissioned all the African regions will be interconnected.

INTER-REGIONAL POWER TRANSFERS

The figure below shows the inter-regional interconnectors (existing, committed and candidate) over the study period [2023-2040]. The projected capacities available by 2040 on the inter-regional links are also provided together with the projected reference peak demand for each region during continental peak demand time.

Existing, committed and candidate inter-regional interconnectors [2023-2040]



To facilitate the levels of transfers depicted, major in-country backbone strengthening is required in some countries. Although most of the in-country backbone strengthening is already included in the Power Pool masterplans, the study also provides a list of the inter-regional transmission corridors and their associated in-country backbone systems. It also presents the cross-border interconnectors that are directly linked to certain generation plants.

Conclusions

The conclusions and recommendations are based on the CMP baseline planned regional integration scenario, which only considers committed and candidate transmission interconnectors identified by the Power Pools.

Based on the network analysis conducted for the CMP baseline scenario, the following conclusions can be drawn:

- The diverse time zones across Africa offer opportunities for regions and countries to take advantage of their different resources and demand patterns. This can lead to a reduction in reserve margin requirements, as well as overall system costs.
- The SPLAT-Africa model has determined that the interconnector capacity utilization selected for the CMP baseline scenario is technically feasible even under peak loading conditions.
- Several countries (including Angola, Cameroon, Congo, Gabon, DRC, Mauritania, Zambia, Zimbabwe, Libya, Ethiopia, Egypt, Tanzania, Nigeria, Niger and Sierra Leone) require additional strengthening of their in-country transmission backbone systems. Plans for such strengthening are already included in the regional masterplans and official country documents. These planned transmission strengthenings are expected to be sufficient to support the projected cross-border interconnector flows outlined in the CMP baseline scenario.

Recommendations

Further studies are recommended in the follow-up phases of the CMP development:

- Similar analysis to be conducted for the CMP regional and continental scenarios during the bridging phase expected from October 2023 to September 2024. These studies could include more dispatch scenarios in addition to the peak dispatch scenario currently considered.
- Dynamic stability studies to assess the impact of higher variable renewable energy (VRE) penetration levels on system stability. The outcome of such studies can serve as a guide on the expected stability impacts of higher VRE penetration and mitigation measures that can be applied to facilitate higher VRE penetration.
- Detailed in-country network reinforcements required under both system healthy (N-0) and N-1 contingency conditions to be studied as part of updating regional or country masterplans.
- Further studies to assess African countries with the highest VRE potential, with a view to assist in developing de-risked VRE parks.