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Short communication

African Clean Energy Corridor: Regional integration to promote renewable energy fueled growth

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ABSTRACT

The Africa Clean Energy Corridor (ACEC) initiative aims to facilitate regional cooperation on promoting regional electricity trade and renewable deployment, allowing to harness tremendous renewable energy potential existing in East and Southern African sub-regions in a "Clean Energy Corridor (CEC)" stretching from Egypt to South Africa. In this short communication, we outline what role renewable energy combined with regional integration plays in meeting Africa's growing energy demand. Results compare an ACEC scenario, where regional cooperation promoting trade and renewable energy deployment would create favorable market conditions for solar and wind technologies, with a business-as-usual scenario where the region decides to deploy more fossil based power while using hydro resources mainly to meet domestic demand. We find both a decrease in overall system costs mainly due to the shift from high cost fossil fuel sources to a combination of further deployment of hydropower in the Democratic Republic of Congo and Ethiopia, complemented by high quality wind potential in East Africa. This scenario would reduce carbon emissions by 40%, compared to a business-as-usual scenario where hydropower potential remains to be used only for domestic purposes. Our model showcases potential costs and benefits of combining regional integration with increased use of renewable energy.

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1. Introduction

Electricity demand in Africa is expected to increase by at least two fold in the next quarter century. Furthermore, sub-Saharan Africa has an extensive untapped renewable potential that could fuel economic growth while providing basic needs in an affordable, secure and environmentally sound way. The role of renewable energy sources, the subject of this Special Issue, is of paramount importance in shaping Africa's future energy system. Africa has five power pools, created starting in 1995, which link together states in East, West, North, South, and Central Africa. These power pools enable states to buy and sell electricity among themselves. While they are not fully operational due to infrastructure, regulatory and capacity problems, many see them as a promising way to accelerate electricity access for citizens and companies in Africa.

The Africa Clean Energy Corridor (ACEC) initiative, put forward by the International Renewable Energy Agency (IRENA) and endorsed by Ministers from countries of the Eastern Africa Power Pool (EAPP) and the Southern African Power Pool (SAPP) at the fourth IRENA Assembly in January 2014 [1], promotes renewable power to support Africa's economic growth. The initiative calls for accelerated deployment and cross-border trade of renewable power in a continuous network from Egypt to South Africa. Four-fifths of all electricity in Eastern and Southern Africa today is generated from carbon-bearing fossil fuels such as natural gas, oil or coal [2,3]. However, half of all electricity in Eastern and Southern Africa could come from clean, indigenous, cost-effective renewables by 2030, allowing for a substantial reduction in carbon dioxide emissions.

Low-carbon economic development powered by renewable energy can help meet the challenge of climate change while improving the livelihoods and economic well-being of millions of people. Regional cooperation can enable the uptake of renewable power projects throughout the EAPP and SAPP countries, sustainably transforming the regional energy mix. (For another example of the intersection between regionalism and renewable energy in Africa, see Hancock in this Special Issue.) Meeting increasing energy demands while ensuring affordability and reducing impact on the environment is not an easy task. Long-term energy systems tools help guide decisions under uncertainty providing insights on the

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scale and impacts of different investment pathways from and integrated and systemic approach.

2. Methodology

To assess this costs and benefits of linking together the two power pools, we use a scenario modeling tool, the System Planning Test (SPLAT), taking into account the retirement of the current power infrastructure, the geographical distribution of renewable resources and the generation-adequacy of the systems, inter alia. We also assess the economic implications of such systems, in terms of investment needs, fuel savings, energy security, etc. This is part of a series of activities that IRENA has been conducting for the five regions in Africa, which overlap with the power pool regions. The findings we discuss here are part of a joint project between IRENA and the Royal Institute of Technology in Sweden (KTH).

The SPLAT model was developed using the modeling platform software called Model for Energy Supply Strategy Alternatives and their General Environmental Impact (MESSAGE), a dynamic, bottom-up, multi-year energy system model applying linear and mixed-integer optimization techniques. The modeling platform was originally developed at the International Institute of Applied System Analysis (IIASA), but more recently has been further enhanced by the International Atomic Energy Agency (IAEA). The modeling platform is a flexible framework within which the actual model is developed.

SPLAT integrates other IRENA tools and databases such as latest renewable costing and technology briefs [4] and a GIS-based estimation of renewable energy resource potentials [5,6]. The investment analysis indicates what power plants to invest in, when to invest, and what their production will be. This is undertaken for each country evaluated. It also determines the level of electricity trade investment and electricity traded between countries. As the future is uncertain, it allows us to explore different options by employing scenarios considering different renewable energy and regional integration conditions aiming at assessing system wide impacts to address issues of supply security, energy access, affordability, environment, financial constraints, etc. We examine two main scenarios:

- Business-as-usual (BAU) assumes current conditions of renewable energy and regional integration.
- ACEC assumes favorable conditions for renewable energy and regional integration.

3. Results

We find that regional cooperation on promoting trading of renewable energy would significantly reduce the CO_2 emissions and total energy system costs, compared with the BAU scenario. Fig. 1 summarizes these findings. Annual CO_2 emission from the power system would nearly double from the current level of 360 Mt CO_2 to over 700 Mt CO_2 by 2030. The ACEC scenario would cut the annual CO_2 emission levels in 2030 by 310 Mt, compared with a case without accelerated enhancement of the renewable technologies. This translates to a savings of 2500 Mt of cumulative CO_2 emissions between 2010 and 2030, allowing the significant de-carbonization of the power sector while increasing electricity supply 2.5 fold. The ACEC initiative suggests that nearly half of the power needed in the region can be met by renewable sources. It would bring economic benefits by reducing the average generation costs (taking into account investment into transmission lines as well) by about 4% mainly through reduced reliance on the fossil fuels, while increasing the economic opportunities associated with major renewable energy investment.

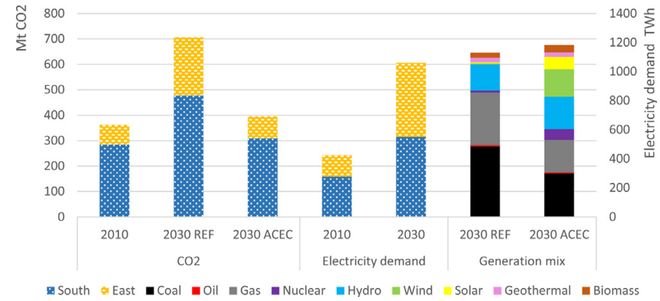

Fig. 1. Comparing business-as-usual scenario with renewable energy and regional integration scenario (ACEC). *Notes*: REF, Business-As-Usual model; ACEC, Africa Clean Energy Corridor; South, Southern African Power Pool; East, East African Power Pool.

Source: Authors' analysis.

In the ACEC scenario, traded electricity amounts to 20% of the total electricity generated, while the existing and currently committed interconnectors would limit the amount to 6%. Trade would promote the deployment of large scale hydro-power, mainly coming from the Democratic Republic of Congo and Ethiopia. Up to 10% of annual CO_2 emission difference between the two scenarios would be accounted for by the trade effects. Two other key drivers for reducing CO_2 emissions include (1) solar photovoltaic (PV) in the Southern African power pool replacing mainly coal-based generation and wind energy in the Eastern African power pool replacing mainly natural gas generation.

4. Conclusions

Access to electricity improves livelihoods. Individuals and businesses depend on it for refrigeration, information and communications technology, and an array of economic, health, social and political services. Higher volumes of electricity are required to increase living standards. Access to electricity is not enough; to further develop, African states also need increasing quantities of electricity. The growth in demand in the countries studied is significant, and many existing power plants are old. Thus there is a rapid rate of expansion in investment. This is needed both to replace retiring power plants and meet new requirements. As these options grow, states need to consider growth in renewable energy options along with fossil fuel generation.

Given the significant potential for investment in supply, use and revenues from operating the power system, there is strong economic incentive to reduce regulatory and other investment risks in the region. Conceivably this might be done in several ways. One is to raise revenue to accelerate the development and capacity of local and regional regulators, operators and planners. Electricity tariffs can be used to raise revenue to support the electricity system. Given the volume of power to be traded, allowing small additional charges to the tariff would more than cover the cost of supporting a well-structured and targeted regulatory system.

We argue in this communication that combining regional energy infrastructure with renewable energy options has the potential to significantly increase access to electricity, as well as the quantity supplied, while also moving toward a more sustainable energy mix.

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