LOW-CARBON ELECTRICITY GENERATION SCENARIOS FOR TANZANIA: IMPLICATIONS FOR THE COUNTRY'S ECONOMY AND THE ENVIRONMENT

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Overview

The causal relation between the use of energy and the economic development of a country is complex topic. In the case of the United Republic of Tanzania, a significant economic growth was registered over the past decade, in the order of 7% of annual GDP. Nevertheless, the electrification rate was only 33% in 2016 (the weighted average of a 65% in urban areas and 17% in rural regions) and it would appear that the consumption of electricity remains limited by a significant lack of infrastructure for power generation and delivery (IEA, 2017). Recent governments have formulated plans and strategies to overcome this issue. Indeed, the country is now looking at energy independence and energy security, relying on local natural resources and imports as well, to guarantee a balanced expansion and diversification of power generation technologies and to increase the share of population with access to modern energy (IRENA, 2016).

In this work, the economic and environmental economy-wide consequences of three prospected electricity development scenarios in Tanzania are assessed over the period 2015-2030. The considered scenarios are based on both International Energy Agency (IEA) and Tanzanian government projections (IEA, 2017; URT, 2016). Their impact is captured mainly by means of the change in total primary energy use of each economic segment, and in the overall primary energy intensity per unit of GDP.

On the one hand, our findings are highly supportive of the government plan to decarbonize the electricity sector. We show that the expected impact of such a policy scenario on both indicators is highly significant. On the other hand, we show that a focus in the electricity sector alone is insufficient to achieve more ambitious goals in terms of reductions in primary energy use and GHG emissions, while enabling economic growth and increasing the country's electrification rate.

Method

This work relies on an Input-Output (I-O) model of the Tanzanian economy. As known, I-O models assume no technological change and no substitutability between inputs, resulting in a matrix of fixed technological coefficients linking primary resources to total domestic production. While these assumptions limit their forecasting accuracy, their flexibility has made them a widely-adopted tool for modeling national and regional economies and estimating broad economic outcomes and policy change implications within a given system's boundary (Hamilton and Kelly, 2017).

To construct an I-O model for Tanzania we use publicly available data and, in particular, we rely on the EORA database to extract the latest (2013) yearly economic transactions for the country (Lenzen et al., 2013). Then, using data from the International Energy Agency, we proceed to transform the monetary EORA table into a hybrid units table, where information on the electricity sector are provided in physical units while the rest of the transactions of non-energy sectors are in monetary currency. Furthermore, the energy sector has been disaggregated by distinguishing several electricity production technologies according to a standard disaggregation protocol (Lindner et al., 2013), relying on country budget updated with information regarding the levelized cost of electricity for different technologies (OECD Nuclear Energy Agency, 2010). Finally, the country's latest projection on electricity demand growth are accounted for (Omri, 2014).

To gain insight into the implications of future development in the electricity sector, the I-O model was coupled with three different scenarios based on IEA projections and national development plans. A Business-As-Usual (BAU) scenario captures the electricity development path under the assumption that no new policies are enacted and constitutes our baseline. The New Policy (NP) scenario internalizes the most recent

government's objectives and planned projects. The so-called 450TZ scenario represents the least-carbon intensive pathway, dominated by renewable energy.

Results

For each scenario, primary non-renewable energy supply and energy intensity of the GDP unit are derived for each five-year interval between 2015 and 2030.

A comparison across scenarios shows a country-wide reduction in the primary non-renewable energy use of, respectively, 10% and 6% in the 450TZ and NP scenarios with respect to the baseline scenario in 2030. As for the electricity sector's use of primary energy, this decreases from 30% of the total primary energy use of the country in 2015 to 27% and 28% in 2030 for the 450TZ and the NP scenarios, respectively. When measured with respect to the baseline, this reduction is significantly larger in the 450TZ (32%) than in NP scenario (19%). Nevertheless, the decrease in energy intensity in the 450TZ and the NP scenarios in relation to the BAU are significantly lower for the other sectors in the economy.

When primary energy intensity of the GDP unit is considered and compared with GDP growth, we find that both the 450TZ and the NP electricity development paths conduct to a decoupling between the economic growth of the country and its energy intensity. Finally, considering each five-year interval, we quantify the contribution of each GW of renewable installed capacity in reducing the primary energy intensity of the GPD unit. This indicator, which can be interpreted as the real effectiveness of renewables in displacing non-renewable energy sources, significantly decreases up to 2020 and remains constant afterwards, suggesting that efforts to further reduce primary energy use should be directed to other energy intensive sector of economy as well (e.g., transportation).

Conclusions

This work explores the impact on the Tanzanian economy and its environment of the expected development of the electricity sector between 2015 and 2030. For this purpose, a hybrid I-O model of the country's economy was constructed and combined with three different scenarios for the development of the power generation sector representing different levels of renewable energy sources in the generation mix.

Efforts to decarbonize the electricity generation sector appear effective in reducing its energy intensity and contribution to the country's GHG emissions. Moreover, they are instrumental in detaching the economic growth of the country from its primary energy use, at least in the medium-term. Nevertheless, to achieve a more significant reduction in the use of primary energy at country-level and/or to limit the growth in GHG emissions over time as the economy growth, it would be important to target other sector of the economy as well – for instance the transport sector, currently the highest contributor to energy intensity and GHG emissions.

Further work should consider the effect of additional policies promoting reductions in energy intensity and GHG emissions across all sectors of the economy, such as measures directed at energy efficiency and/or incentive-based instruments designed to curb carbon emissions.

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