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Achieving renewable energy-centered sustainable development futures for rural Africa

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Multi-dimensional and overlapping Nexus challenges affect many parts of rural sub-Saharan Africa. More than 90% of cropland is rainfed, less than one third of households have electricity at home, more than 15% of people report insufficient food intake and more than 40% of people live below the poverty line. Climate change impacts on vulnerable systems with limited adaptive capacity and strong population growth are increasing the magnitude of the challenge. As a result, there is a strong need for multi-level, multi-sector interventions (from national policies to regional/river basin-scale planning, to local planning and investment). To implement such actions, it is key to assess solutions (technology and investment) and appraise their feasibility and implementation potential (from both a policy and a financial point of view). In this study, we soft-link bottom-up process-based water and energy demand and techno-economic infrastructure assessment models into a multi-node, national Nexus-extended Integrated Assessment Model (MESSAGEix-Nexus) for supply and investment assessment. Based on the integrated modelling, we obtain an understanding of the role of an explicit consideration of (productive) energy access jointly with Water-Agriculture-Food interlinkages for rural Nexus infrastructure requirements, investment, and sustainable development objectives. This demonstrates how climate impacts and water and energy needs affect each other and jointly shape infrastructure and investment pathways. Then, by linking technical models with business models analysis, we are able to assess feasibility of implementation and appraise which are the key micro and macro determinants to ensure feasibility, investment, and uptake of small-scale Nexus infrastructure, crucial for rural development and adaptation to changing climate conditions. Altogether, our research demonstrates how national-scale integrated modelling with an explicit focus on Nexus interlinkages allows for assessing locally-relevant demand sources and investment needs, and their implications for sustainable development. In turn, this allows for deriving policy and investment-relevant insights.