UNIVERSAL ENERGY ACCESS, AGRICULTURAL GROWTH, AND SUSTAINABLE LAND USE: POLICY ROADMAP TO 2050

KEY RECOMMENDATIONS

- **Create coordinated support for investments in agriculture mechanization of USD 18 billion through 2050**, extension of electricity access, and extension of *surface-based* irrigation, to achieve the National Energy Compact's ambitious targets of increased wheat, maize, and soybean production.
- **Support the upscaling of distributed solar PV** to 260 MW by 2030 and 370 MW by 2050 to provide low-cost, electricity-driven water pumping for irrigating 26,130 ha of small-scale farming.
- **Deploy 4,270 MW of utility-scale solar PV, 260 MW of distributed solar PV, and 3,500 MW of onshore wind power by 2030 as the least-cost options** to contribute to the IRP's target for non-hydro renewable electricity supply, for use in bulk electricity supply and farming electrification.
- **Reduce reliance on coal** to achieve a 21% decrease in electricity costs and a 24% reduction in direct CO_{2eq} emissions by 2050.

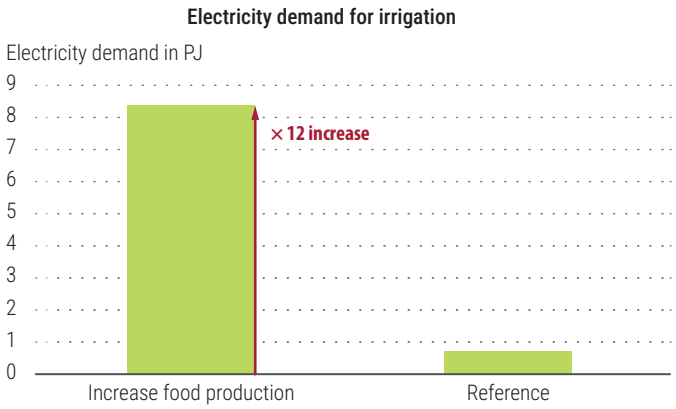
SUPPORTING ENERGY ACCESS, AGRICULTURAL DEVELOPMENT, AND SUSTAINABLE LAND USE

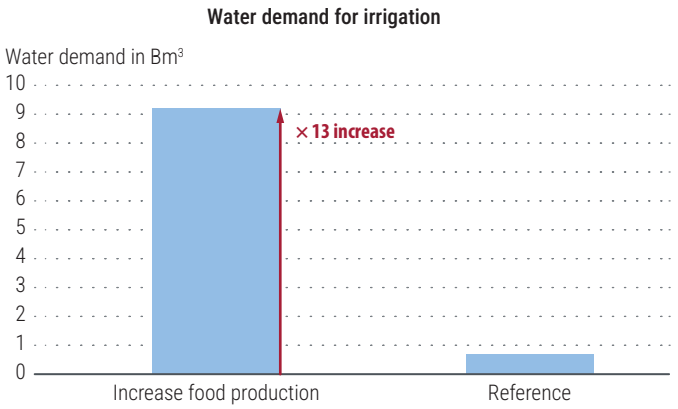
There is a need for integrated land, energy and water resource use planning to achieve the Zambia National Energy Compact's ambitious targets of domestic production of maize, wheat, and soybean. To support this growth and improve climate resilience, national plans call for increasing non-hydro renewable energy to 33% of the electricity mix. These shifts in agriculture and energy will significantly affect land use, highlighting the need to better align energy and agricultural planning under Zambia's national development and energy policies.

By using a Climate, Land, Energy and Water systems (CLEWs) modelling framework, we highlight the importance of creating coordinated support for investments in mechanization of agriculture, extension of electricity access to farms, and surface-based irrigation. The least-cost option to contribute to the Integrated Resource Plan (IRP) and 8th National Development Plan's target for non-hydro renewable electricity supply is through the upscaling of utility-scale and distributed solar PV, plus onshore wind.

IMPLICATIONS OF THE NATIONAL ENERGY COMPACT'S 2030 AND 2050 CROP TARGETS FOR LAND, WATER, AND ELECTRICITY PLANNING

The targeted increase in wheat, maize, and soybean production (proportional to population growth) leads to a **71% increase in harvested cropland** and a shift from small- to commercial-scale agriculture to increase yields and keep up with the production targets. The share of commercial-scale harvested land increases from 10% to 50% in 2050, resulting in maize, wheat, and soybean harvested areas covering 24.7% of rainfed and 19.8% of irrigated commercial-scale farming by 2050.





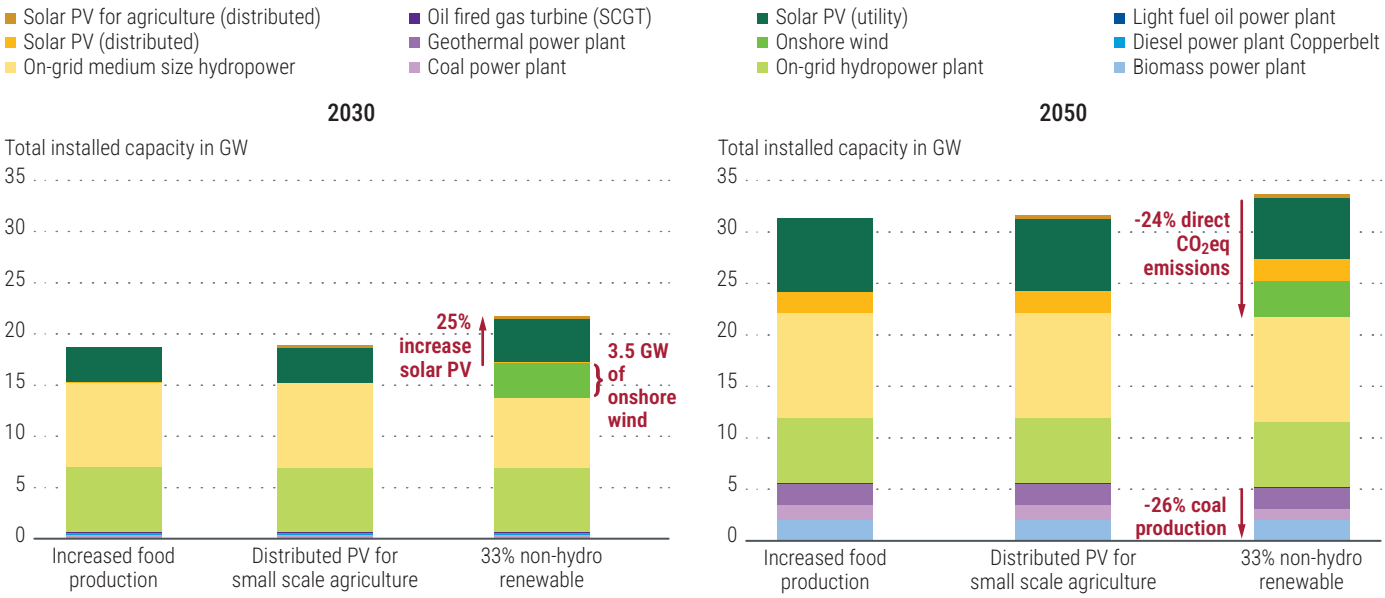
This, in turn, increases the energy requirement 12 times and the water requirements 13 times to achieve the productivity boost. In particular, **water demand for irrigation increases to 9.21 billion m³** in 2050, a level that appears sustainable given Zambia's 57.4 billion m³ of groundwater reserves. However, climate change could cause seasonal recharge imbalances and potentially pose a challenge. A proportional increase in the use of electricity for water pumping is also expected (170 MW of additional installed power or 8.37 PJ of electricity supplied). Energy & water for irrigation are thus enablers of a more climate-resilient agricultural sector. Distributed solar PV in particular can counterbalance the increase in land-use change CO_2eq emissions (22% increase in 2030–2050) while carrying the potential to mitigate the exposure of small-scale farming to prolonged droughts.

THE ROLE OF DISTRIBUTED SOLAR PV AND NON-HYDRO RENEWABLES IN ACHIEVING ZAMBIA'S ENERGY AND CROP PRODUCTION TARGETS

Introducing distributed solar PV as the electricity source for water pumping in small-scale agriculture requires 260 MW of installed capacity by 2030 and 370 MW by 2050, with a 3% increase on the cumulative, system-wide capital costs over all years. Synergies exist with the IRP's 33% target of non-hydro, renewable electricity supply alongside a 25% increase in utility scale solar PV capacity (4.27 GW) and 3.5 GW of onshore wind by 2030. Appropriate siting of solar PV has the potential to electrify the agricultural sector while mitigating the exposure of small-scale farming to prolonged droughts. Moreover, it presents a low-cost opportunity to enhance the resilience of electricity supply to climate shocks, mitigate the aforementioned land-use-change impacts (−24% in direct CO_2eq emissions), and reduce by 26% the reliance on coal — which would reduce by 21% the variable costs of electricity by 2050.

THE WAY FORWARD

For IRP's **industrialization** of the agricultural value chain (particularly for irrigation) **distributed solar PV** offers a cost-effective & scalable solution for small farmers while reducing the reliance on centralized grids and enhancing energy access. The shift to renewable energy will require mobilizing USD 18 billion through 2050 and careful spatial planning to ensure small farmers benefit from a just transition — coupling CLEWs with geospatial electrification models can provide deeper insights into optimal deployment pathways for grid and off-grid solutions. Future analytical work should expand the representation of the agricultural sector to capture the full production chain (e.g., livestock or agro-processing activities) and strengthening the accuracy of emissions accounting through dedicated GHG inventories will also be critical to better assess sectoral impacts. As **irrigation expands**, careful assessment of groundwater use & climate-related risks will be needed to ensure long-term water sustainability and avoid unintended resource stress.



Authors

Muchima Mulunda — **University of Zambia**

Camilla Lo Giudice, Fancesco Gardumi — **KTH Royal Institute of Technology**

Clement Njobvu — **Centre for Energy, Environment and Engineering of Zambia**

Jethro Mwanza, Fredrick Mwenya Mubanga — **Zambia Electricity Supply Corporation**

Eric Musama — **Energy Regulation Board**

This brief was prepared under the capacity development activities of the Economic Analysis & Policy Division (EAPD) of the United Nations Department of Economic & Social Affairs (DESA). The Project is funded by the United Nations Peace & Development Trust Fund. For more information, please contact Alfonso Acosta Gonçalves, EAPD/DESA (acostagoncalves@un.org). The content, findings, interpretations, and conclusions expressed do not necessarily represent the views of the United Nations or the Member States.