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An investigation of the impact of bounded rationality on the decarbonisation of Kenya's power system

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Research Purpose

How can we transition to a low-carbon energy supply to limit the effects of climate change?

The methodology of quantitative energy models can have an impact on the advice inferred. We compare Kenya's electricity system transition to 2050 with a 2-model inter-comparison. To explore the uncertainty, we use an agent-based simulation model (MUSE [1, 2]) and an optimisation model (OSeMOSYS [3]).

Methods

MUSE: Modular energy system Simulation Environment

- ✓ Simulation
- ✓ Open Source
- ✓ Heterogeneous bounded-rational agents
- ✓ Limited foresight

OSeMOSYS: Open Source energy MOdelling System

- ✓ Optimisation
- ✓ Open Source
- ✓ One Central "Agent" Planner
- ✓ Perfect foresight

Harmonisation

Demand
Full
Electricity demand by period and timeslice

Technologies
Full
Technological options
Initial Costs and learning rates
Growth rates

Policies
Partial
Limited to increased electrification of demand sectors

Discussion

- ✓ Geothermal is the dominant power source, growing to about 200 PJ, filling the rapidly increasing electricity demand for Kenya.
- ✓ Onshore wind grows for both models by 2050.
- ❖ A higher fraction of fossils (oil ad coal) remains in MUSE compared to OSeMOSYS
    - ❖ Decommissioning assumptions: once installed, in MUSE capacities cannot become stranded, whereas in OSeMOSYS the perfect optimisation approach allows early retirement to reduce the overall system costs
- ❖ MUSE privileges higher capacity factor renewable technologies (biomass); OSeMOSYS privileges other renewables (Solar PV (Rooftop), offshore wind and medium hydropower plants)
    - ❖ Foresight assumptions: In OSeMOSYS, the falling costs of renewables are known at the start of the simulation, however, in MUSE, investors must react to the falling price. This causes delay in their uptake.

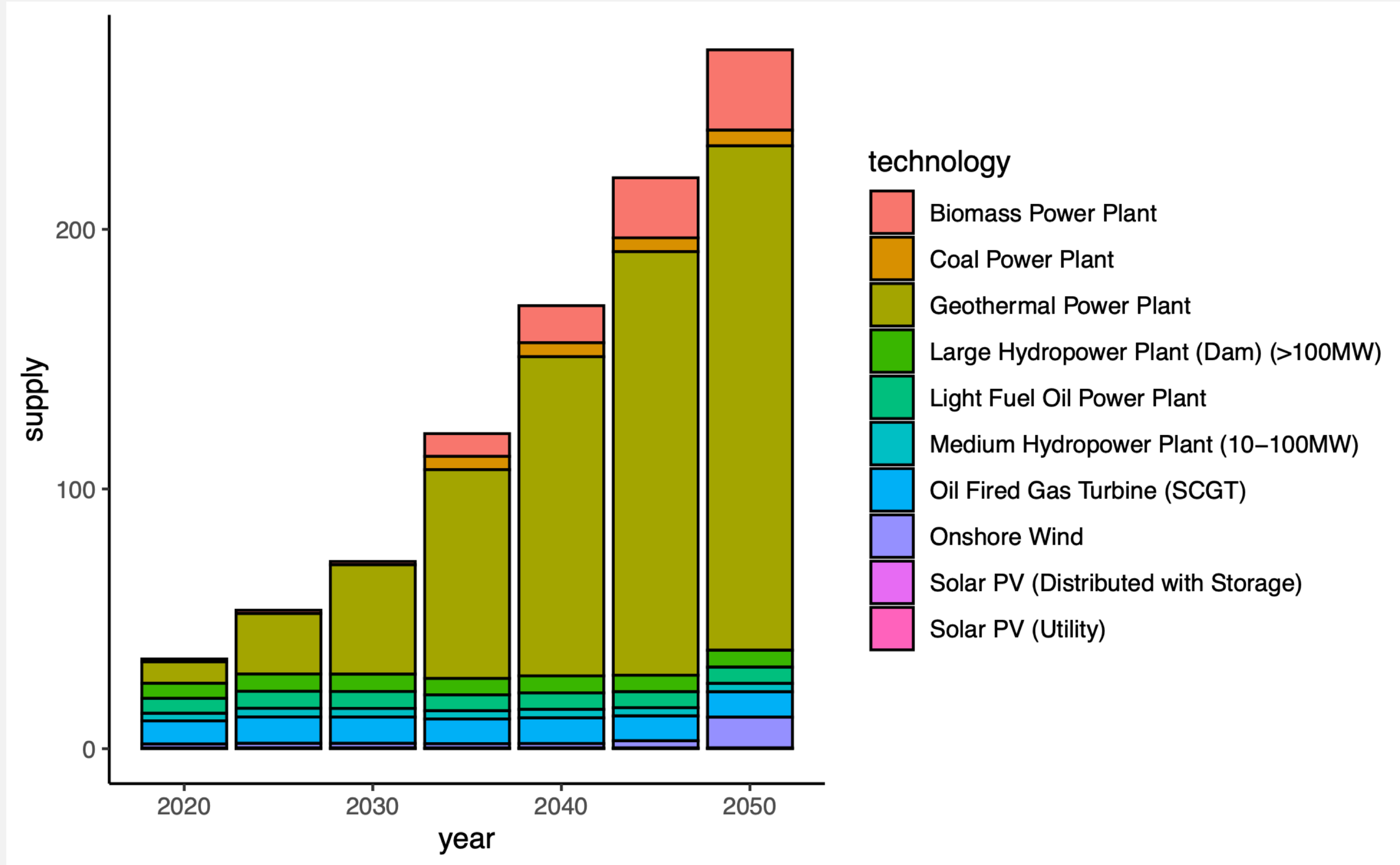
Conclusion

The use of fully harmonised open source data [4], which allows full transparency of the input assumptions, can increase the confidence in the model results to inform policies in the power sector in Kenya.

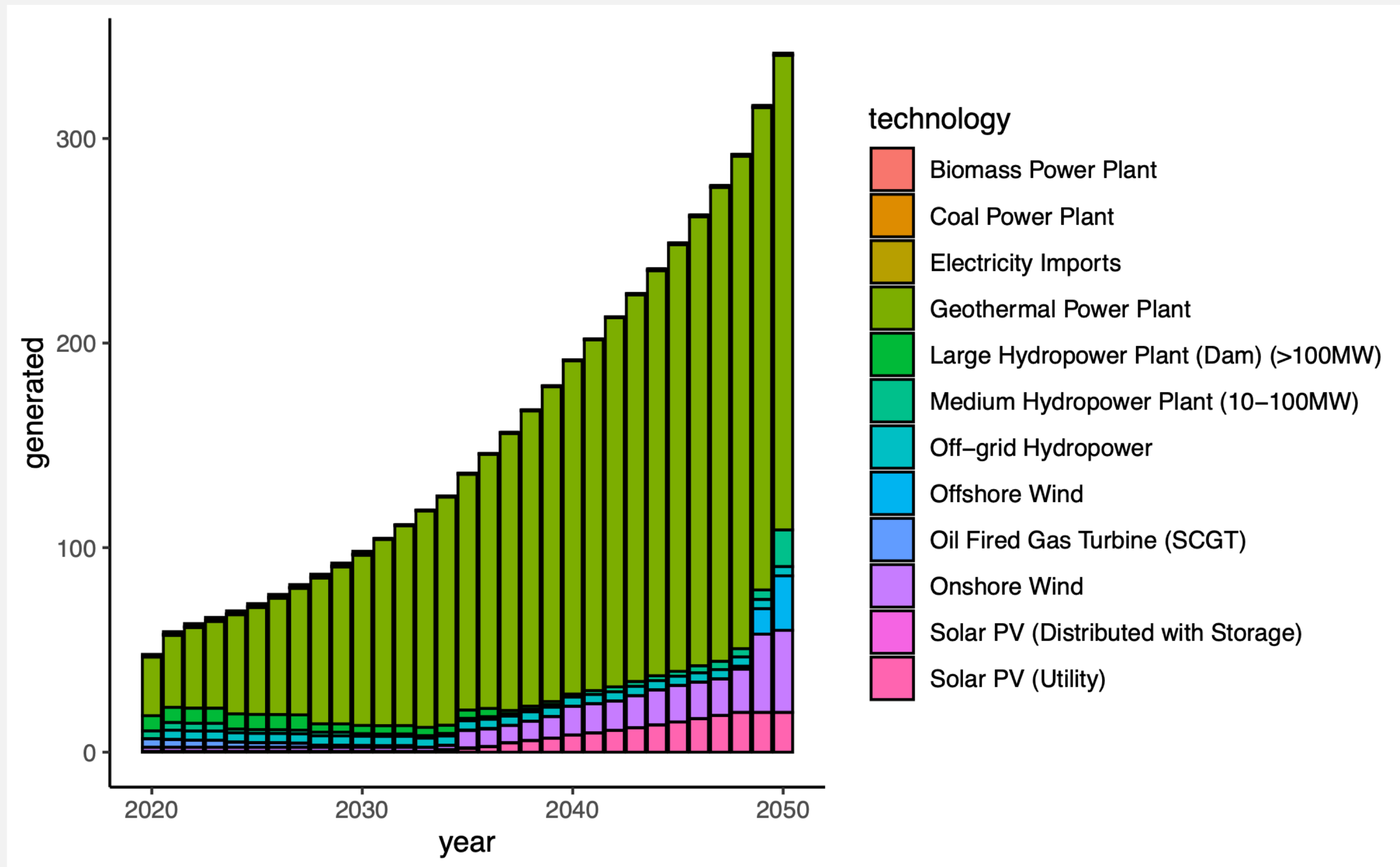
Despite some differences on selected technologies, the models agree on the dominant technology, geothermal, which would fulfil the energy demand in Kenya between 2020 and 2050.

If the positive economics of solar PV, offshore wind and medium hydropower plants were underestimated (assuming the imperfect foresight of conservative investors), investments in biomass power plants would be preferred, as shown in MUSE.

Results: electricity generation



Electricity generation for Kenya with the MUSE model.



Electricity generation for Kenya using the OSeMOSYS model.

Share of electricity generation

Power Type	year	MUSE (%)	OSeMOSYS (%)
Fossil fuel	2030	23	1
Fossil fuel	2050	8	0
Intermittent renewables	2030	3	2
Intermittent renewables	2050	5	25
Non-intermittent renewables	2030	74	96
Non-intermittent renewables	2050	87	75

References

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[3] M. Howells et al., "OSeMOSYS: The Open Source Energy Modeling System. An introduction to its ethos, structure and development.," Energy Policy, vol. 39, no. 10, pp. 5850–5870, Oct. 2011, doi: 10.1016/j.enpol.2011.06.033.

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