Getting to 100% Clean Power by 2030: Building Robust Decision-Making into Kenya's Energy Planning

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Summary

Kenya's ambition to achieve a fully clean power system by 2030 raises questions about how to provide system flexibility as renewable penetration increases. Applying Robust Decision-Making (RDM) enables a structured assessment of alternative flexibility options, including natural gas and battery storage, across a wide range of uncertain futures. The results show a limited role for natural gas, provided that modest cost reductions in batteries are achieved, and support the use of planning approaches that test strategies for robustness rather than relying on a limited set of scenarios.

Key Messages

- Wind, solar, and geothermal energy are expected to drive future capacity expansion, increasing the need for system flexibility to maintain reliability.
- Natural gas contributes to flexibility in a limited share of scenarios and typically at low utilisation levels, while substantial investment in batteries is observed consistently across all futures.
- Incorporating uncertainty into planning supports more robust decisions and should be integrated systematically, rather than relying on deterministic scenario analysis.
- Decisions on flexibility provision require complementary enabling conditions, including appropriate regulatory frameworks, investment incentives, and attention to financing constraints that may affect the deployment of different technologies.

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Pipelines of Olkaria Geothermal Power Station in Kenya

1. Introduction

Kenya has long led the way in the use of renewable electricity to meet its energy access and economic development goals [1]. With 88% of electricity generation coming from renewable sources [2], its stated ambition, reaffirmed as part of Mission 300, is to achieve '100% clean energy sources on the national grid by 2030' [3, p.7].

A key question for planners concerns the provision of system flexibility. As Kenya further expands its grid capacity to meet growing demand, and increases its share of renewable electricity, it will need to manage system stability and reliability while ensuring affordable electricity supply to consumers.

This is particularly the case as solar and wind are likely to provide much of the additional capacity, while there is limited scope for further large-scale hydropower expansion and geothermal is expected to provide stable baseload capacity. Flexibility requirements beyond what hydropower can provide are therefore likely to depend on natural gas, battery storage, or a combination of both.

Natural gas, which is considered a 'clean energy source' for the purposes of the 2030 goal, is being strongly considered by the Government of Kenya. In the Energy Policy published in 2025, the Government states that it will 'facilitate development and utilization of natural gas and associated infrastructure for power generation' [4, p.61].

Recent news reports suggest that plans for Kenya's first gas generation plant at Dongo Kundu in Mombasa are advancing [5]. At a capacity of 1,200 MW, this plant would be reliant on imported LNG and require a regasification plant to handle gas cargoes.

Previous scenario-based exercises in Kenya have suggested a role for gas in the power generation sector [6–8]. However, there are a range of concerns about an increased reliance on imported gas. Firstly, gas prices are volatile and have recently spiked again due to conflict in the Middle East. This exposure to price volatility may be a challenge when needing to deliver affordable electricity supply. Secondly, new gas generation capacity and import infrastructure will need to be built. If gas is to be used as peaking capacity for flexibility at low utilisation rates, this calls into question the economic viability of this new infrastructure. Thirdly, observed and projected cost reductions in battery storage raise concerns about potential lock-in effects associated with investment in natural gas infrastructure and stranded assets.

Given the uncertainties facing planners around such key planning decisions, this policy brief sets out the need for more systematic consideration of uncertainty in planning for flexibility options and sets out insights on the use of an approach called Robust Decision-Making (RDM).

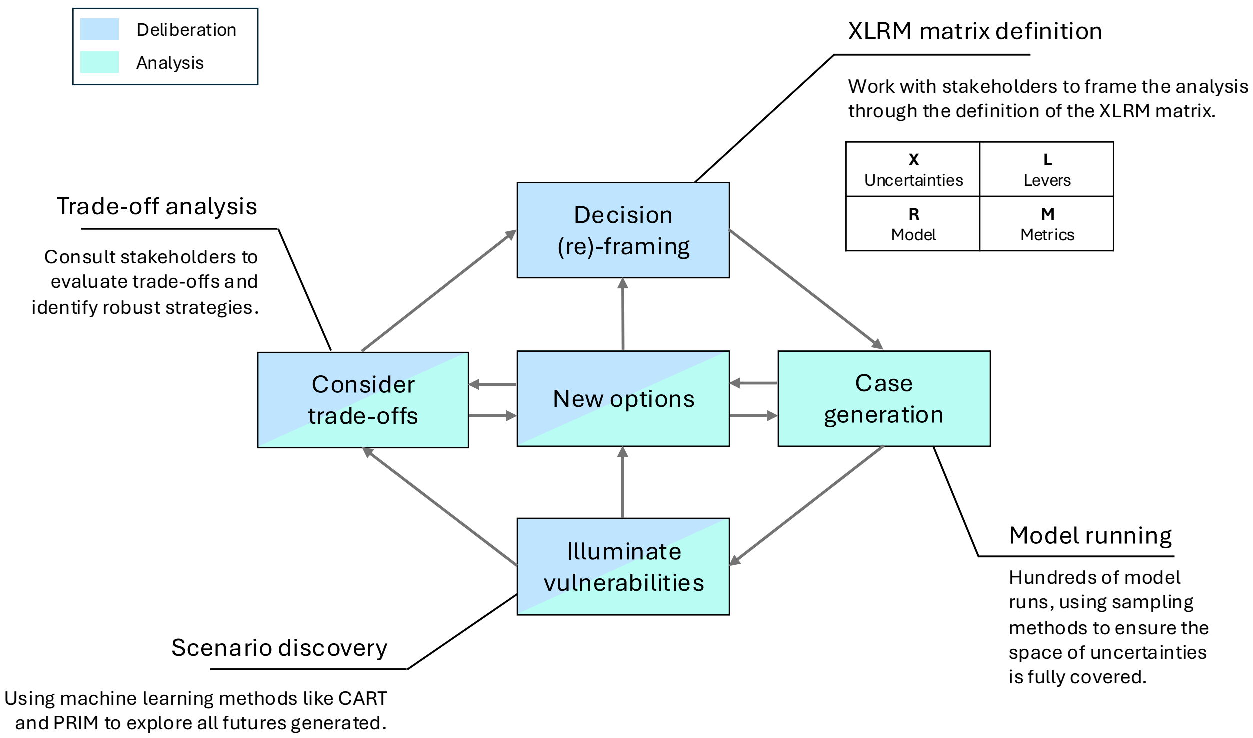
2. A shift in planning practice: from optimality towards robustness

Scenario modelling is a key tool for planners worldwide. The standard practice is for deterministic models to be applied prescriptively to optimise decisions for achieving policy goals or to simulate the impact of policies and targets. A small number of scenarios are typically used to explore alternative futures. However, this approach means that multiple uncertainties impacting planning are not captured, and this may lead to planning decisions that are not robust across a wider range of future outcomes.

RDM addresses these limitations by moving beyond optimisation for a single predicted future. It combines exploratory modelling with stakeholder engagement to stress-test strategies across a wide range of uncertain futures, identifying approaches that remain robust not just across a limited set of scenarios, but across the full range of plausible outcomes planners may face. Building on previous work using the OSeMOSYS model [7, 8], and in collaboration with the Kenyan Least Cost Power Development Plan (LCPDP) team, RDM (**Figure 1**) was applied to power system planning in Kenya to assess the role of future flexibility options.

The approach follows an iterative, participatory process initially centred on the development of an XLRM framework. This framework maps key uncertainties facing planners, the levers available to decision makers, the modelled relationship between them, and the performance metrics used to evaluate strategies. The identified uncertainties are then assessed within an energy system model (here, OSeMOSYS) to generate an ensemble of scenarios representing a wide range of plausible energy system futures. This ensemble is subsequently analysed using machine learning techniques to identify scenarios that fail to meet policy objectives and to characterise robust strategies, with a particular focus on system flexibility and on the conditions under which natural gas is deployed.

***Figure 1:** Robust Decision-Making process, adapted from Marchau et al [9]. For each step, additional detail on the methods applied is provided. Darker and lighter shades of blue distinguish between deliberative and analytical steps, highlighting where both are involved. Arrows indicate the iterative nature of the process.*



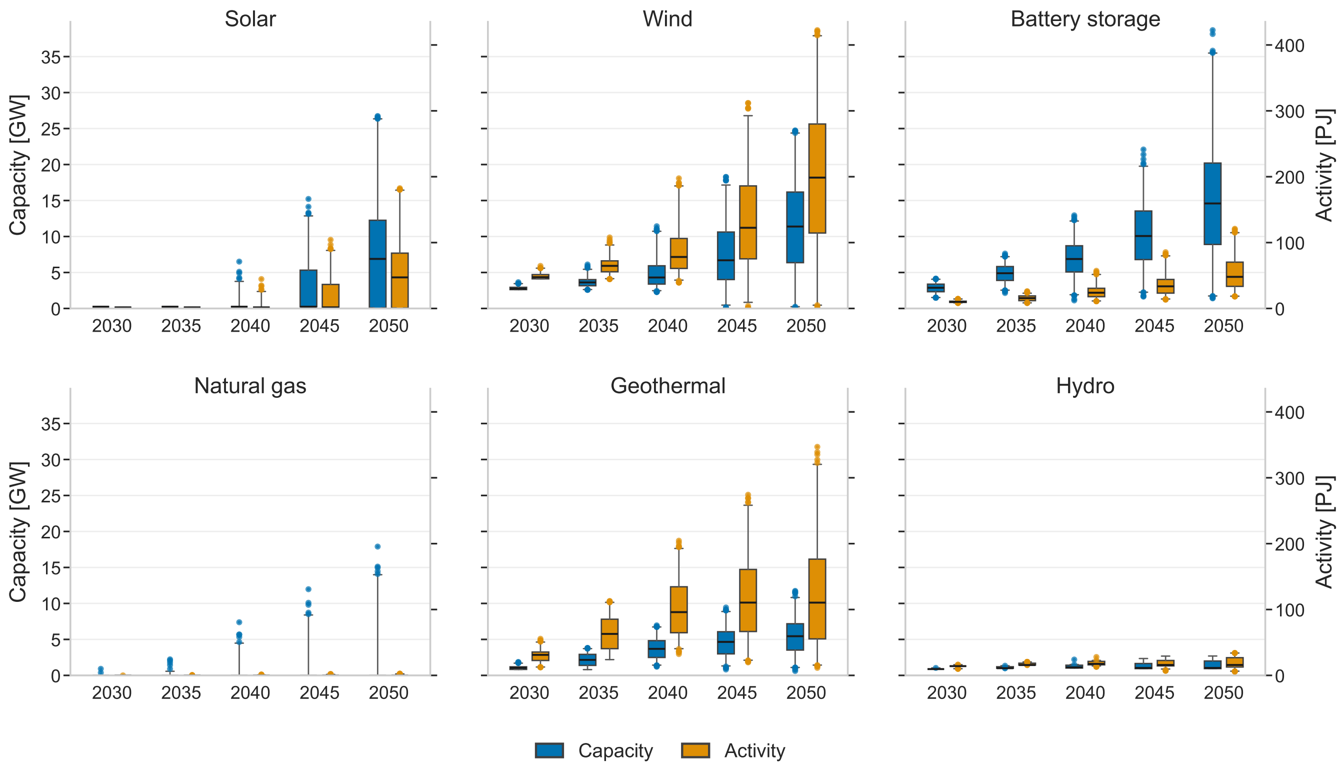
3. Assessing flexibility needs for Kenya's power system

The RDM-based exploration of the uncertainty space highlights three main findings of relevance to power system planning. First, wind, geothermal, and solar emerge as key technologies underpinning the growth of the electricity system. They account for the majority of capacity additions and electricity generation after 2030, highlighting the growing importance of system flexibility over time. **Figure 2** shows the evolution of capacity and generation across key technologies to 2050, across the full range of modelled futures.

Second, the role for natural gas as a flexibility provider is limited, appearing in only around 15% of scenarios. Even in those scenarios, utilisation remains low, accounting only for a negligible share of generation. The analysis indicates that the key determinants of a limited role for natural gas are a modest reduction in the cost of grid-scale batteries relative to current prices, to around 800 USD/kW, and the cost of capital associated with investments in clean technologies such as solar, wind, and batteries.

Third, a strategy that positions natural gas to provide baseload or sustained load-following generation through investments in combined-cycle power plants, would increase total system costs across the full range of futures, raising the risk of stranded assets and underutilised infrastructure.

***Figure 2:** Installed capacity and annual activity for key technologies. Each subplot shows the range of installed capacity (blue, left axis) per technology per year over the entire set of futures modelled, as well as the annual electricity production per each technology (orange, right axis). For batteries, discharging only is showed.*



4. Insights for planning

Adopting an exploratory modelling approach strengthens planning by producing insights that remain robust across a wide range of plausible futures. Rather than diminishing clarity, explicitly accounting for uncertainty improves the reliability of the evidence base and should be treated as a core component of effective strategic decision-making. Modelling, however, remains a decision-support tool, and decisions still need to be taken. The analysis points to battery storage as a preferred option for providing flexibility and, given continued cost reductions globally [10], a robust choice to make. Pursuing this pathway would reinforce Kenya's leadership in renewable energy and fossil fuel phase out.

Delivering this strategy requires aligning investment incentives for new battery capacity and ensuring that the cost of finance does not constrain deployment. Additional enablers are needed to overcome key challenges to scale up and roll out batteries, including having the right regulatory framework in place and building skills and supply chains to service this sector [11].

A focus on batteries for flexibility would also avoid investment in costly new fossil fuel infrastructure to both import gas and generate electricity, as well as exposure to global gas price volatility, which has recently increased due to the conflict in the Middle East. As of 25 March 2026, the gas price on the Dutch TTF (which sets the price of European LNG cargoes) had risen by 80% since the conflict started. Such volatility does not only impact prices but also the potential availability of LNG cargoes, which will be diverted based on price competition.

While the analysis points strongly to batteries as a key enabler of flexibility, additional considerations are relevant. First, natural gas may play a role in sectors beyond power, which could result in a stronger argument for infrastructure investment. Second, more detailed analysis is needed to ensure that flexibility needs can be met in the battery-focused systems proposed. Third, alternative flexibility options, particularly on the demand side, have not been tested.

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