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EnerGoal

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Project Overview:

This project evaluated potential energy generation scenarios for Saudi Arabia in preparation for hosting the FIFA World Cup 2034. The objective was to investigate how different energy mixes, including natural gas and renewable energy resources, could satisfy the expected increase in electricity demand while maintaining reliable and cost-effective system operation.

The project used the PLEXOS energy market simulation platform to build a Long-Term Expansion Planning model covering 2027–2034, and solved three scenarios — Base, FIFA_2034_Summer, and FIFA_2034_Winter — to compare how World Cup timing affects national capacity investment, generation cost, emissions, and reserve margin. This final report presents the completed model results.

Final Project Report

Date: August 24, 2026

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1 Project Objectives and Goals

The primary objective of this project is to investigate possible future energy mix scenarios for Saudi Arabia in preparation for hosting the FIFA World Cup 2034. Using the PLEXOS Long-Term Expansion Planning (LT Plan) model, the project evaluates how different electricity generation portfolios can meet the expected increase in electricity demand while ensuring system reliability and operational efficiency.

The project also aims to:

- Analyse future electricity demand over a 2027–2034 planning horizon.
- Evaluate different energy generation scenarios for Saudi Arabia under Summer and Winter World Cup timing.
- Assess the impact of various energy mix configurations on future power system planning.
- Develop a simulation model using PLEXOS to support long-term energy planning.
- Produce analytical results and visualisations to support evidence-based decision making.

2 Methodology and Model Configuration

Three PLEXOS scenarios were built and solved on an identical 2027–2034 horizon: Base (no World Cup), FIFA_2034_Summer, and FIFA_2034_Winter, each reflecting a +6% national demand uplift during the respective World Cup window. Configuration work completed:

1. Adjusted generator and expansion-candidate data, including capacity-related settings and expansion limits.
2. Configured candidate generation technologies — CCGT, CCGT Cogen, OCGT, and Steam Cogen — per region, with Units = 0 so the LT model determines when and how many units to build.
3. Set candidate maximum capacity per region based on existing generation capacity and recommended sizing.
4. Configured maximum build limits: up to 20 units total, up to 10 units per year.
5. Configured the 2026 validation horizon and the 2027–2034, hourly, full-chronology planning horizon.
6. Configured the 10-Year Plan, linked to the planning horizon and the LT Partial planning phase.
7. Created and linked the FIFA 2034 scenario (Scen_FIFA_2034) to the 10-Year Plan.
8. Linked horizon, scenario, LT Plan, and report objects to prepare the model for execution.
9. Ran PASA validation to confirm the base system, load data, generation fleet, and reserve settings were functioning correctly.
10. Executed the Long-Term Plan for all three scenarios. All three completed with zero infeasibilities.

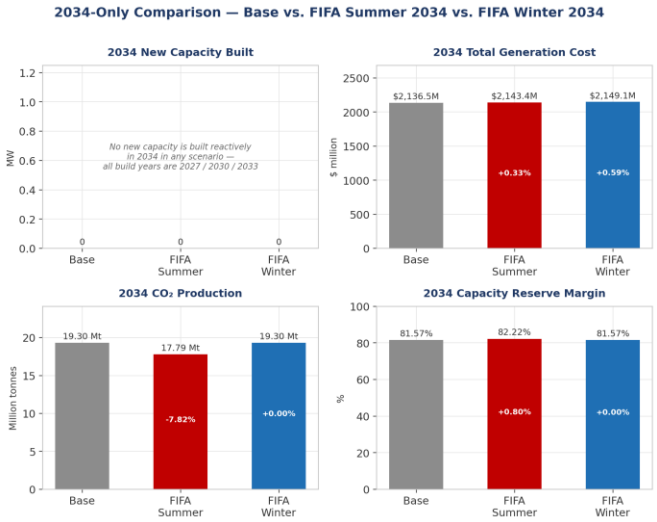
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3 Key Findings

All results below isolate the 2034 fiscal year specifically. Multi-year totals are not used as headline figures because LT Plan re-optimises the full 2027–2034 investment plan simultaneously — once 2034 demand differs between scenarios, cost and emissions shift in every other year too, even years where demand is identical across scenarios. The 2034-only comparison is the defensible measure of the World Cup's own effect.

Metric (2034)	Base	FIFA Summer 2034	FIFA Winter 2034
National peak load	92,141.6 MW	92,141.6 MW (unchanged)	92,141.6 MW (unchanged)
New capacity built	0 MW	0 MW	0 MW
Total generation cost	$2,136.5M	$2,143.4M (+0.33%)	$2,149.1M (+0.59%)
CO_2 production	19.30 Mt	17.79 Mt (−7.82%)	19.30 Mt (+0.00%)
Capacity reserve margin	81.57%	82.22% (+0.65 pts)	81.57% (+0.00 pts)



2034-only comparison across all four metrics tested, Base vs. FIFA Summer vs. FIFA Winter.

Headline results

- The World Cup never sets a new annual national demand record in either timing scenario — the true structural peak (92,141.6 MW, 24 August) is identical across all three scenarios.
- No new capacity is ever built reactively in 2034 in any scenario; all new capacity across the whole horizon is built in 2027, 2030, or 2033, consistent with realistic construction lead times.
- FIFA_2034_Winter is identical to Base on capacity, emissions, and reserve margin, in every year tested — essentially zero measurable national impact, and only a marginal cost increase (+0.59%).
- FIFA_2034_Summer requires a small amount of additional national capacity (+600 MW, ~0.8% above Base) with a modest cost increase (+0.33%), but this comes paired with a reserve-margin improvement (+0.65 pts) and an emissions reduction (−7.82%) relative to Base — a trade-off, not a straightforwardly negative result.
- National capacity reserve margin declines structurally from ~96% (2027) to ~82% (2034) across all three scenarios identically — a longer-horizon capacity-planning trend independent of the World Cup.
- The four candidate technologies that account for every scenario difference are OCGT_Candidate_EOA (Summer only, +30,003 MW cumulative), OCGT_Candidate_NEOA (Winter's distinguishing technology), and OCGT_Candidate_SOA / OCGT_Candidate_NWOA (built less in the World Cup scenarios than in Base) — no other generator in the fleet shows any variation across scenarios.

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4 Model Scope and Limitations

- Single national node: regional adequacy questions (e.g. NEOM, Al Khobar) cannot be validated against this model — answering them requires rebuilding with genuine multi-node regions and transmission corridors.
- LT Plan and PASA phases only, not full chronological dispatch: reliability metrics that depend on a dispatch simulation (EENS, EDNS, LOLE, LOLP) were not available from these solves.
- Cost and emissions figures populate for a subset of generators (chiefly expansion candidates), so absolute $ and tonne totals likely understate true system-wide figures, though scenario-to-scenario comparisons remain internally consistent.

5 Conclusions

Under this model's assumptions, hosting the 2034 FIFA World Cup does not create a material national-level strain on the Saudi power system, in either a Summer or a Winter tournament calendar. Winter is the more conservative outcome on every metric tested; Summer involves a small, mixed trade-off rather than a clear cost.

6 Project Timeline

Task	Target Completion
Data Collection	15 July 2026
LT Plan Implementation	31 July 2026
Simulation and Results	2 August 2026
Poster Preparation and Results Visualisation	16–20 August 2026
Additional Analysis and Research	20–22 August 2026
Final Report	24 August 2026

7 Challenges

- Ensuring the candidate generator capacities and build limits were correctly configured for each region.
- Aligning the planning horizons, scenario, and LT Plan to ensure proper model execution.
- Verifying the model results and ensuring the LT optimisation completed without infeasibilities.
- Interpreting scenario-vs-Base differences correctly given the single-node model structure and the full-horizon re-optimisation effect on multi-year cost and emissions totals.

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