WHEN SYSTEMS GROW UP

HOW FUTURE-READY POWER SYSTEMS TAKE SHAPE

PROLOGUE: THE NIGHT BEFORE

On a humid evening in Freetown, a planner closes the day-ahead forecast and listens for the generator to fall silent. Upcountry, the Moyamba solar-plus-battery mini grid, commissioned last May, gives a small town an evening heartbeat it never had before. In the capital, the files for Newton and Lungi – large-scale PV-plus-storage developed under the World Bank's Regional Emergency Solar Power Intervention (RESPITE) programme – sit ready for the next step. Together, these signals suggest Sierra Leone is beginning not just to procure clean power, but to do so repeatedly, using the same structures that can be scaled and replicated.

The Green Cities, Infrastructure, and Energy Program (GCIEP) operates precisely in the space between these two realities: between the small proof point in Moyamba and the system-wide templates now emerging in Freetown.

> IT IS THE KIND OF WORK THAT RARELY ENDS UP IN HEADLINES, BUT WITHOUT WHICH GRIDS CANNOT ABSORB RENEWABLE ENERGY AT SCALE.

From Freetown to the wider set of countries where GCIEP operates, similar shifts are taking place. This article draws on those experiences to explore the challenges of building resilient power systems – and the features and lessons that make them future-ready. Across these experiences, four features consistently shape whether power systems become future ready: credible institutions, bankable procurement, financial realism and operator capability.

Advancing renewable energy in the Solomon Islands: solar solutions supporting more sustainable and resilient energy systems.

RESILIENT INSTITUTIONS & REGULATORY CERTAINTY

Where rules are unclear, uncertainty becomes costly. Investors pad their prices, utilities delay decisions, and governments discover that ambition has no traction. Credible institutions, whether an integrated plan that is actually used or a regulator whose decisions explain themselves, are what turn individual projects into a coherent system.

In Solomon Islands, this barrier is acute. A small, dispersed grid gets roughly 90% of its electricity from diesel, making power among the most expensive in the Pacific. Draft legislation for an independent energy regulator is moving forward with political backing, marking a shift away from discretionary sector governance. GCIEP has worked with the government on the structure and process of this reform – the careful, behind-the-scenes drafting and stakeholder choreography that ensure the new regulator fits the realities of a small, islanded system rather than an idealised model. The result should be an environment where investors understand how tariffs are set and licenses granted, allowing solar and storage providers to compete with diesel on price rather than wrestling with administrative uncertainty.

Ethiopia provides a contrasting but equally telling example. Here, instead of missing institutions, the risk was that the NEP (National Electrification Program) 2.0 – one of the most sophisticated geospatial, integrated electrification plans globally – would remain a static document rather than function as a living roadmap. GCIEP's role has been to reinforce routines that connect planning to delivery: updating data layers, clarifying institutional roles, and ensuring donor financing

pipelines align with the plan's sequence. The expected outcome is a sector where grid densification, off grid solutions and donor operations work in synchrony rather than at cross-purposes, reducing stranded investments and improving the credibility of electrification targets.

BANKABLE, TRANSPARENT PROCUREMENT & COMMERCIAL FRAMEWORKS

Procurement is where power systems either professionalise or unravel. When Power Purchase Agreements (PPAs) are bespoke, bidding timelines vague, and risk poorly allocated, costs rise and renegotiations follow. When procurement becomes standardised and predictable, developers start planning around a market, not just a single project.

Sierra Leone illustrates the transition from inconsistency to discipline. With the commissioning of Moyamba, rural mini-grids now sit alongside utility scale Photovoltaic+Battery Energy Storage Systems (PV+BESS), moving through standardised competitive tenders under the RESPITE programme. GCIEP has supported the upstream alignment of planning, procurement and operations: introducing standard templates, clearer risk allocation, and improved forecasting and dispatch routines inside the utility. When Newton and Lungi eventually synchronise with the grid, commissioning should be smoother: the system operator will know what to expect and how to absorb intermittent generation.

> THE RESULT IS A SYSTEM WHERE FUTURE TENDERS CAN BE LAUNCHED ON THE BACK OF THOSE ALREADY COMPLETED – REDUCING COST, SHORTENING TIMELINES AND TURNING ONE-OFF TRANSACTIONS INTO A REPEATABLE PROCUREMENT MODEL.

Zambia's challenge is different: mini-grids often failed not because of technology, but because demand lagged. The Zambia Energy Demand Stimulation Incentive (ZEDSI), launched in November 2024, addressed this by subsidising early connections for productive uses, including clinics, farms, schools, and small businesses. The first awards, made in June 2025, cover 43 mini-grids and an initial set of around 100 priority sites. Complementary regulatory work showcased in Lusaka has clarified how developers should operate and connect. GCIEP has supported government counterparts in reframing electrification as an economic systems issue – where refrigeration, milling and irrigation matter as much as kilowatts. If ZEDSI succeeds, developers will build sites with greater confidence that demand will follow, and Zambia could offer a replicable model for rural mini-grids across the region.

FINANCIAL REALISM & RISK MANAGEMENT THAT SURVIVES POLITICS AND THE WEATHER

A power system that cannot manage its finances cannot grow. Losses, non-collections, and opaque tariff-setting translate into arrears, bailouts and higher risk premiums. But tariffs cannot simply rise; without social protection, reform quickly unravels. Financial realism is therefore a choreography of discipline and empathy.

Training for Ghana Grid Company, focused on advancing leadership in variable renewable energy integration through financial modelling and economic analysis.

In Ghana, the Government's Energy Sector Recovery Programme (ESRP) and a 2024 World Bank Programme-for-Results (PforR) target precisely these fundamentals: reducing losses, improving collections, implementing cash waterfall mechanisms and expanding clean cooking. Sector transfers of 2% of GDP reflect how chronic the issue has become. GCIEP has supported government teams on the operational aspects – rolling out metering that actually reduces receivables, ensuring dispatch follows least-cost priorities, and building quarterly dashboards to track improvements. The aim is a utility that pays its bills, clears arrears and lowers the risk premium investors add to every bid.

In the Kyrgyz Republic, winter demand peaks and hydrological volatility make tariff setting a politically charged exercise. A 2025 World Bank Development Policy Operation supports

tariff reform with social protection, greater transparency and the preparation of Kambarata-1 as a regional flexibility asset. GCIEP has contributed by structuring scenario modelling that allows ministers to see, in plain terms, how different seasonal and pricing scenarios affect imports, arrears and household impacts. A credible tariff path, paired with targeted protection, can stabilise the sector and attract private renewables that would otherwise shy away from uncertainty.

As part of a pilot on revenue protection in Freetown, Sierra Leone, GCIEP trained 25 staff members from the Electricity Distribution and Supply Authority in customer mapping, energy accounting and meter inspections

OPERATORS WHO CAN RUN COMPLEXITY, NOT JUST BUILD CAPACITY

As solar PV and battery storage appear, power systems shift from fuel-driven to coordination-driven. Instead of worrying about diesel deliveries, operators must forecast, schedule and integrate increasingly distributed assets. Poor routines can undo excellent technologies.

In Sierra Leone, with PV+BESS on the way and mini-grids online, operations needed to mature before modern processes can be integrated. To support this, GCIEP has helped introduce manual day-ahead forecasting, dispatch protocols and data hygiene practices. These routines reduce curtailment risk for new plants and make commissioning more predictable. The result is not only fewer surprises, but a workforce preparing, in real time, for the more complex, renewables-based grid it will soon run.

In Zimbabwe, operational complexity has collided with policy ambiguity. Hydropower variability at Kariba – from restricted allocations in 2024 to partial recovery in early 2025 – has shown how quickly supply can swing, even as interest in distributed PV and storage has grown. The missing element had long been the technical plumbing: rules for interconnection, protection, and metering. GCIEP worked with the Ministry of Energy and Power Development to co-develop the national mini-grid policy framework, built through consultations with over 100 stakeholders from 52 institutions in Mutare and Gweru, and supported parallel work with regulators on distributed generation interconnection specifications, net metering and licensing updates. These steps provide a route for developers to connect systems safely and predictably, strengthening the distributed arm of the country's National Energy Compact, which targets universal access and 70% clean cooking by 2030.

LESSONS FOR FUTURE READY POWER SYSTEMS

Across the countries where GCIEP works, a handful of lessons recur with striking regularity. The first is that systems change sticks when reforms are sequenced, not stacked. In Sierra Leone, for example, RESPITE's standardised tenders only began to create momentum once upstream operational routines, manual day-ahead forecasting, dispatch protocols, and data hygiene were introduced within the utility. Without that, the commissioning of PV+BESS plants would simply have revealed new operational weaknesses rather than solved old ones. In Zambia, demand stimulation through ZEDSI succeeded not because subsidies existed, but because they arrived alongside regulatory clarity and a pipeline of priority sites. When rules, incentives and real-world- usage line up, investment becomes replicable rather than accidental.

A second lesson is that credibility matters more than complexity. Solomon Islands did not need a world-class electricity regulator; it needed one whose decisions were transparent, predictable and appropriate for a dispersed, diesel-heavy grid. Ethiopia, for its part, demonstrated that a plan like NEP 2.0 becomes powerful only when institutions actually follow it – refreshing geospatial data, coordinating donor sequencing, and grounding decisions in the same least- cost- pathway. Policy reform is often presented as technical sophistication; in practice, the countries that advance are those that choose consistency over novelty.

A third lesson lies in the political economy of financial realism. Ghana's experience with the Energy Sector Recovery Programme and the 2024 World Bank PforR shows that loss reduction, collections and clean cooking interventions become politically feasible when paired with transparency and communication. Similarly, tariff reform in the Kyrgyz Republic, under the 2025 Inclusive Growth Development Policy Operation (DPO), only gains durability when supported by social protection and clear modelling of seasonal impacts. No country escapes the arithmetic of arrears; what distinguishes progress from stasis is whether governments see the math in time.

A fourth lesson, often overlooked, is that operators are the hinge. Hydrological shocks at Kariba in Zimbabwe, from constrained allocations in 2024 to partial recovery with improved 2025 rainfall, exposed not just the fragility of supply, but also the importance of dispatch discipline and interconnection rules for embedded PV and storage. Zimbabwe's development of a national mini grid policy framework and updated interconnection specifications for distributed generation have begun clearing the technical bottlenecks that stopped developers from scaling even when demand was there.

> THE LESSON IS STARK: TECHNOLOGIES DO NOT FAIL IN MINIATURE; THEY FAIL AT THE POINT WHERE PEOPLE MUST OPERATE THEM.

Taken together, these cases point to a final insight: future ready- systems grow from the middle, not the margins. They depend on mid-level procurement officers who use the same template twice, dispatch teams who forecast tomorrow as a habit rather than a favour, analysts who refresh data, ministries that publish losses, and regulators who answer calls with reference to rules rather than personalities. GCIEP's work, whether in Lusaka or Honiara- or Freetown, sits in this quiet stratum of the sector - the place where reforms, once too delicate to survive contact with reality, turn into routines.

The way forward is therefore clear. Countries need institutions that hold, procurement that repeats, finances that add up, and operators who run the grid they have, while preparing for the one they will inherit. They need distributed assets integrated into clear frameworks, hydropower risks priced with honesty, and planning documents that serve as navigation charts rather than press releases. Above all, they need help making reforms liveable: not lofty, not fragile, but workable.

In that sense, the most important outcome across GCIEP countries may be this: systems are learning to behave like systems. Processes are tightening. Decisions are starting to rhyme. And the quiet, incremental work that rarely earns a headline is, piece by piece, creating grids that can absorb the future and not resist it.

CODA: BACK TO THE PLANNER

The planner in Freetown shuts his laptop. Tomorrow's forecast might still be off by a notch, but it won't be a guess. A small town has a reliable solar battery backbone; the capital is learning to buy clean power using the same rules twice; a regulator on a Pacific island is nearly ready for parliament; a Zambian clinic may soon refrigerate vaccines without fear; a Ghanaian ledger could balance for the first time in years; a Kyrgyz winter is finally being costed before it arrives; and a Zimbabwean developer can open the interconnection guide and find instructions, not ambiguities.

> FUTURE-READY SYSTEMS ARE NOT BUILT BY ANNOUNCEMENTS. THEY GROW FROM RULES THAT HOLD, PROCUREMENT THAT REPEATS.

Finances that add up and operators who understand tomorrow's grid. GCIEP's role is simply to help this growth happen in the places where it matters most.

MORE ABOUT THIS SERIES

This article is the first in a series on the Green Cities, Infrastructure and Energy Programme (GCIEP), exploring global trends across key sectors – including transport, energy, water and waste management – and how projects are advancing climate resilience and sustainable solutions in practice.

GCIEP is a global programme funded by the UK's Foreign, Commonwealth & Development Office (FCDO), working across more than 70 projects in 24 countries to accelerate sustainable infrastructure and climate-resilient urban development. The programme provides technical assistance, capacity building and policy support to governments, public agencies, investors, businesses and UK partners – helping to strengthen enabling environments and mobilise finance for low-carbon, resilient and inclusive infrastructure.

Over the past two years, ASI has delivered GCIEP across a diverse set of countries, including: Democratic Republic of Congo, Ethiopia, Ghana, Kyrgyzstan, Laos, Mauritius, Mozambique, Nigeria, Philippines, Senegal, Sierra Leone, Solomon Islands, Sri Lanka, Tanzania, Ukraine, Vietnam, Zambia, and Zimbabwe.