
GHD
Accelerating the electric grid for a net-zero future
→ The Power of Commitment

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Executive summary

The global push for net-zero emissions has placed unprecedented pressure on electricity transmission networks – the critical link between renewable energy generation and end users. Despite their importance, these networks face severe bottlenecks, including supply chain disruptions, permitting delays, and cross-border regulatory barriers, all of which hinder the rapid expansion required to meet decarbonisation goals.

This thought leadership paper draws on GHD's project delivery experience to highlight the urgent need to modernise and accelerate grid development through more agile and collaborative delivery models. Traditional Engineering, Procurement, and Construction (EPC) approaches are increasingly misaligned with the speed, scale, and complexity of today's energy transition. In contrast, delivery models such as PD and Alliancing offer alternative pathways to reduce delays, align incentives, and optimise resource use.

It's important to note that the barriers to grid expansion vary significantly by region. In highly regulated environments such as the EU, for example, planning reform and public buy-in are especially critical to accelerating transmission deployment. Similarly, the relevance and applicability of collaborative delivery models like IPD and Alliancing may differ across markets based on regulatory frameworks, contractor maturity, and institutional readiness.

With annual investments in transmission and distribution grids expected to surge from US$260 billion today to US$820 billion by 2030[1], embracing smarter, more flexible approaches to project execution is no longer optional – it is essential. By learning from successful models and fostering collaboration across borders and sectors, the transmission sector can become a key enabler of a resilient, net-zero energy future.

The transmission challenge in decarbonisation

Electricity transmission networks are essential enablers of the clean energy transition, acting as the critical link between renewable generation sources – such as wind, solar, and hydropower – and the end users who depend on reliable, affordable electricity. While substantial progress has been made in scaling up renewable energy capacity, the infrastructure required to transmit this power efficiently and equitably has not kept pace.

This shortfall presents a growing risk not only to electricity system reliability and emissions reduction goals, but also to the broader decarbonisation ecosystem. Modern transmission networks are not just about electrons – they underpin the availability of low-emissions molecules, too. Future fuels such as hydrogen, green ammonia, and sustainable aviation fuel (SAF) rely on access to clean, abundant electricity to drive their production through electrolysis and other processes. Without a resilient, modern transmission grid, the energy needed to power these emerging fuel pathways will remain stranded.

Bridging the transmission gap is, therefore, central to both sides of the energy equation – power and fuel – and must be treated as an urgent infrastructure priority. As governments and industries intensify their net-zero commitments, closing this gap is no longer a choice– it is a necessity.

So, what are the barriers preventing rapid transmission expansion, and how can innovative delivery models help accelerate progress?

Breaking the bottlenecks: Barriers to grid expansion

The transmission sector's ability to scale rapidly is impeded by several structural challenges.

Supply chain constraints

Disruptions in the supply of essential materials have significantly delayed grid modernisation efforts and the situation is only worsening. Global demand for key components such as transformers, conductors, insulators, and high-voltage equipment is outpacing supply, leading to lead times stretching into years in some cases.

These constraints are no longer isolated incidents – they are systemic. With manufacturers operating at or near capacity, traditional just-in-time procurement approaches are proving inadequate. As a result, project proponents are increasingly shifting towards long-term framework agreements to pre-book manufacturing slots and secure supply well in advance of final project approvals.

This shift represents a critical evolution in project planning. Securing manufacturing capacity early – sometimes even before project scoping is complete – is now a prerequisite for staying on schedule. Without these strategic supply arrangements, even well-funded, technically advanced transmission projects risk substantial delays due to equipment bottlenecks.

Regulatory and permitting delays

Approval timelines for transmission projects frequently span seven to ten years or more, particularly in jurisdictions with complex environmental regulations or multi-agency oversight. Cross-border initiatives are further hampered by fragmented regulatory frameworks and inconsistent planning protocols[2]. These delays not only slow progress toward net-zero goals but also erode investor confidence and increase project costs. Streamlining permitting processes, standardising approval pathways, and engaging regulators early in project design are critical to removing roadblocks. Countries that fail to modernise their regulatory systems will find themselves outpaced in the global energy transition.

Community and environmental concerns

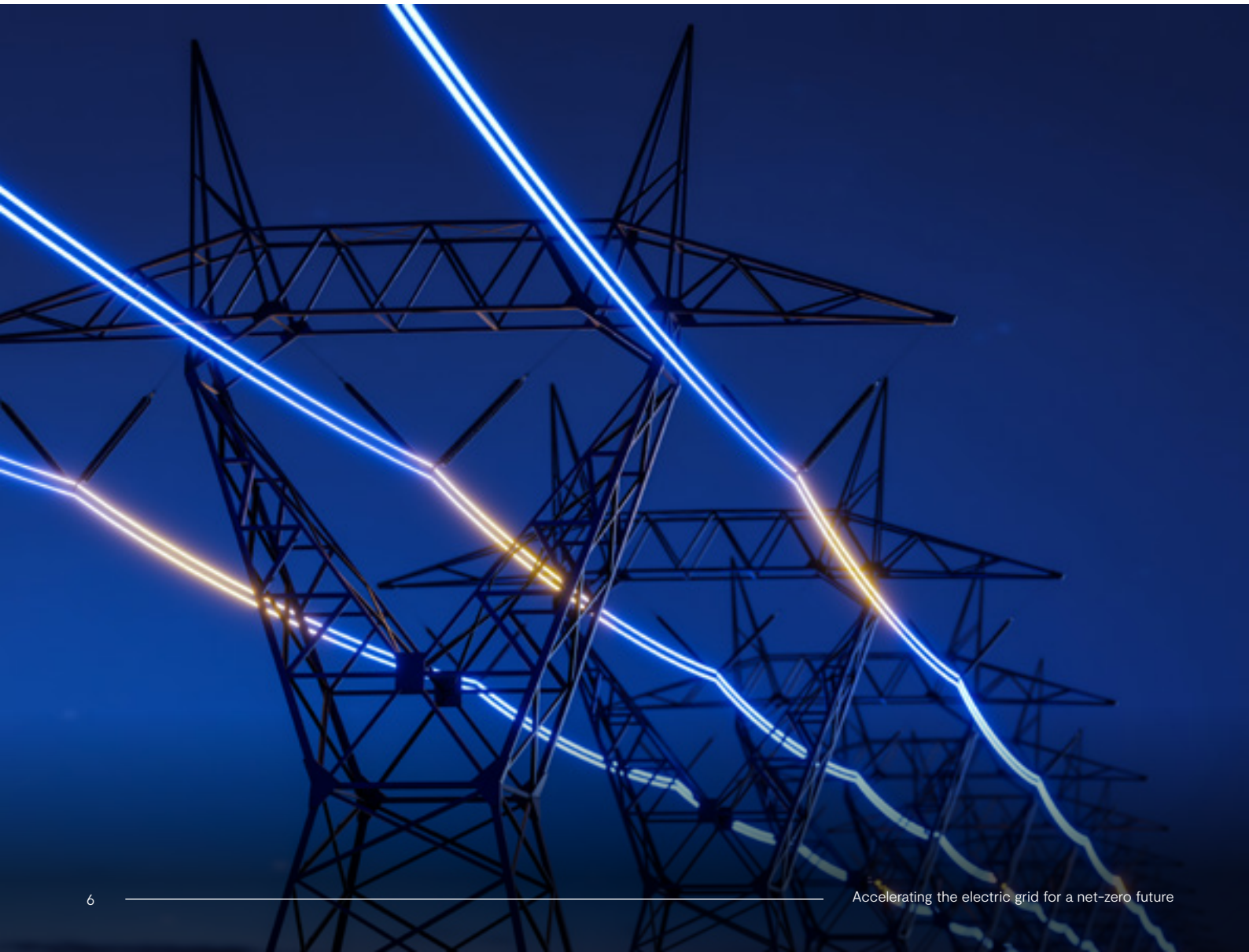
Transmission corridors often pass through ecologically sensitive landscapes or regions with strong community identity, creating public concern and, sometimes, legal challenges. Perceptions of environmental harm, cultural disruption, or lack of consultation can derail even the most technically sound projects. Early, transparent engagement with local communities, Traditional Owners, and environmental stakeholders is no longer optional – it is a strategic imperative. Co-design approaches, clear benefits sharing, and proactive environmental stewardship must be embedded into project planning to avoid delays, build trust, and secure lasting social licence.

Increasing energy demand

The dual challenge of decarbonising electricity generation while meeting rapidly rising energy demand is intensifying pressure on transmission networks. Electrification of transport, industry, and buildings is accelerating, driving exponential growth in power consumption. At the same time, new sources of demand – such as data centres, hydrogen production, and electric vehicle charging infrastructure – are emerging at scale. This shift requires not just more generation, but more grid capacity, flexibility, and resilience. Without significant investment in transmission infrastructure, the risk of congestion, curtailment, and reliability issues will grow and undermine the energy transition and stall economic decarbonisation efforts.

Figure 1: Key challenges in the transmission sector (source: GHD analysis)

Challenge	Description
Regulatory hurdles	Lengthy permitting processes that vary across regions can delay projects significantly.
Environmental concerns	Transmission infrastructure, including overhead lines, underground, and subsea cables, often intersects with environmentally sensitive areas, leading to complex regulatory and ecological considerations.
Stakeholder concerns	Local commnities and environmental groups can oppose transmission projects, causing delays or cancellations
Cross-border coordination	Coordinating projects across multiple jurisdictions requires regulatory aligument and estensive collaboration
Funding concerns	Uncertainty and risk concerns among investors can slow down project development.
Supply chain disruptions	Disruptions, along with limited capacity and competition in global supply chains, make it difficult to source critical materials such as semiconductors and rare earth metals.



Changing strategies:

Why traditional approaches often fall short

Traditional EPC, Design & Construct (D&C), and Design then Construct (D-then-C) models can be hindered by rigid structures and siloed contracts, limiting collaboration and information flow. These strict boundaries are increasingly inadequate for modern, complex transmission projects requiring flexibility and integration.

The nature of EPC – where entire projects are tendered and priced prior to design development – can lead to costly delays when unforeseen issues arise. Misaligned incentives can further contribute to inefficiencies, as each party focuses on their own contractual obligations rather than project-wide success. Cost overruns, scope creep, and poor risk management are common challenges, exacerbated by fragmented delivery models that slow down project progress.

However, another school of thought suggests that the structured sequencing inherent to D-then-C models can in fact help mitigate delays by allowing issues to be addressed in a controlled and predictable manner. In this view, having a fully resolved design prior to construction provides certainty in pricing and reduces on-site ambiguity and project scheduling. Moreover, in many utility-led projects – especially where standardised designs are critical to system integrity and life-cycle asset management – early constructor input is already integrated into the design phase, whether through internal expertise or collaborative processes.

Traditional models may also limit innovation and adaptability. Separating design and construction phases can reduce opportunities for contractors to contribute insights early, potentially resulting in less efficient or more expensive outcomes. That said, some experienced practitioners argue that even within these conventional models, there are well-established mechanisms for construction teams to provide feedback during design development, particularly when projects are led by clients with deep operational and technical knowledge.

With evolving energy technologies and shifting regulations, project delivery frameworks increasingly need to support agile responses to change, where possible. While fixed scopes, standardisation and rigid structures may be effective in certain contexts, they can struggle to accommodate mid-project shifts in requirements, leading to delays and increased costs.

The International Energy Agency's *World Energy Outlook 2022*[3] highlights the urgency of a faster clean energy transition, emphasising the need for more effective project delivery models to accelerate electricity transmission infrastructure.

As a result, alternative approaches like Integrated Project Delivery (IPD) and Alliancing are gaining traction. These models promote collaboration, flexibility, and agility, ensuring more efficient and resilient project execution.

Key characteristics of Integrated Project Delivery (IPD):

Early stakeholder involvement:
Key participants (owner, designer, contractor) collaborate from the start, often before design completion.

Collaborative decision-making:
Joint problem-solving leverages the expertise of all team members.

Shared risk and reward:
Financial incentives are aligned with project success, encouraging a "best for project" mindset.

Reduced liability exposure:
Encourages open communication and innovation without fear of litigation.

Multi-party contract:
A single agreement binds all key stakeholders, reducing conflicts from separate contracts.

Enhanced integration:
Promotes seamless coordination between all project participants, including trades and suppliers.

Key characteristics of Alliancing:

Relationship-based model: Emphasises trust, good faith, and a "no blame, no disputes" philosophy.

Jointly developed target cost: Establishes a realistic budget agreed upon by all stakeholders.

Shared risks and reward: All participants share financial outcomes, fostering a collective project focus.

Pain/gain share arrangements: Financial performance is shared based on a pre-agreed formula.

Open-book financial transparency: Ensures clear and honest contract pricing among all alliance partners.

Unified success or failure: All parties either win together or lose together, eliminating adversarial dynamics.

Figure 2: Comparison of project delivery models in electricity transmission (source: GHD analysis)

Aspect	**EPC** (Engineering, Procurement, Construction)	**IPD** (Integrated Project Delivery)	**Alliancing**
Flexibility	Low	High (early involvement of all parties)	Medium-high
Collaboration	Limited	High (early, cross-functional collaboration)	Very high (all parties under a single contract)
Risk distribution	Primarily on contractors	Shared among all stakeholders	Shared across the alliance
Cost overruns	Frequent due to rigid contracts	Reduced through shared goals	Reduced through collaboration
Time delays	Common due to lack of flexibility	Lower due to adaptable approach	Lower due to cooperative environment
Innovation capacity	Limited due to structured roles	High, fosters innovation	Encourages innovation through partnership
Stakeholder engagement	Minimal, late-stage involvement	Strong, early-stage engagement	Very strong, joint stakeholder management

There is no ‘one-size-fits-all’ strategy

The comparison reveals that while EPC offers a clear contractual structure and a single point of responsibility, it often falls short in terms of flexibility, collaboration, and innovation. These are crucial aspects for navigating the complexities of modern electricity transmission projects driven by the energy transition.

IPD and Alliancing, on the other hand, are specifically designed to address these shortcomings by fostering a collaborative environment, sharing risks and rewards, and promoting a "best-for-project" approach.

Choosing the appropriate project execution strategy is essential as, quite often, no single model suits all projects. While PD and Alliancing offer strong collaboration and risk-sharing benefits, their effectiveness depends on key project drivers such as:

Cost constraints:
Some projects require fixed pricing, while others benefit from flexible cost-sharing models.

Schedule urgency:
Fast-tracked projects may need streamlined decision-making, whereas complex projects may prioritise early collaboration.

Contractor availability:
Limited contractor capacity may favour models that encourage long-term partnerships.

Ultimately, the best execution strategy is one that aligns with the project’s unique challenges, ensuring the right balance of flexibility, risk management, and efficiency to drive successful outcomes. Execution strategies for large transmission projects and programs need to be selected using a rigorous process to ensure the best fit that will lead to success.

The power of international and inter-regional collaboration

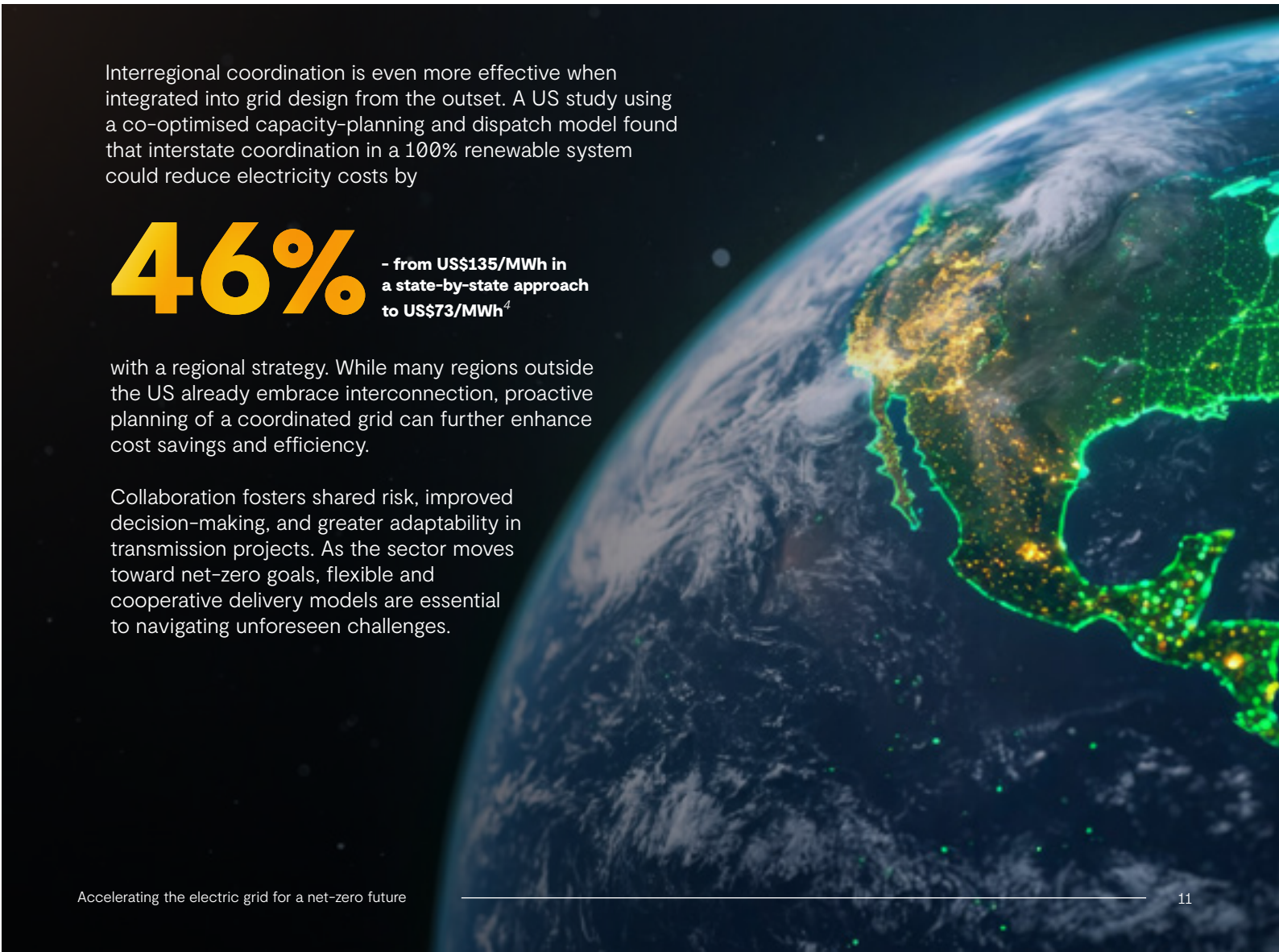
International and inter-regional collaboration is crucial for cross-border transmission projects, ensuring smoother execution and greater efficiency. The North Sea Wind Power Hub exemplifies this approach, bringing together multiple countries to develop an interconnected offshore wind energy system. By engaging stakeholders early and coordinating efforts across borders, the project demonstrates how shared planning can streamline energy transmission, reduce costs, and accelerate deployment.

Interregional coordination is even more effective when integrated into grid design from the outset. A US study using a co-optimised capacity-planning and dispatch model found that interstate coordination in a 100% renewable system could reduce electricity costs by

46% **- from US$135/MWh in a state-by-state approach to US$73/MWh**[4]

with a regional strategy. While many regions outside the US already embrace interconnection, proactive planning of a coordinated grid can further enhance cost savings and efficiency.

Collaboration fosters shared risk, improved decision-making, and greater adaptability in transmission projects. As the sector moves toward net-zero goals, flexible and cooperative delivery models are essential to navigating unforeseen challenges.



Case studies: Highlighting collaborative and flexible delivery models

KBESS2 sets new standard for battery project delivery through Synergy and GHD partnership (Western Australia)

In response to the Western Australian government's plan to retire coal-fired power stations by 2030, Synergy, the state's largest energy generator and retailer, expedited the delivery of its Kwinana Battery Energy Storage System – Stage 2 (KBESS2). GHD was selected as the consulting partner for this time critical battery project in WA.

The KBESS2 project was delivered using an Integrated Project Management Team (IPMT) structure, consisting of Synergy and GHD team members from diverse technical and management disciplines. This approach enabled breaking down traditional organisational boundaries and overcoming complex engineering and delivery challenges, contributing to its successful execution within a time-critical schedule – just three months from Final Investment Decision (FID) to the start of construction, 13 months for construction, and only four months from commissioning to the first power transfer to the grid.

The IPMT implemented robust collaborative protocols, including transparent reporting and communication structures, aligned project governance, shared risk management and comprehensive compliance frameworks. This collaborative model ensured both organisations worked as a cohesive team, united by shared culture, aligned objectives, and open communication channels, enabling them to meet the project's tight schedule while maintaining its financial stability.

Beyond project delivery, this partnership established new industry best practices, including the Major Project Delivery Standard, initiated during KBESS2 and refined for the subsequent Collie Battery Energy Storage System (CBESS) project. By prioritising collaboration, Synergy and GHD have not only delivered a technically sophisticated infrastructure project but have also set a new benchmark for integrated project delivery in the energy sector.

Convertus York Biofuel Facility (Canada) sets new standard for sustainable waste management

The Convertus Group (Convertus) York Biofuel Facility is set to become the largest biofuels project in Canadian history - a $490 million initiative over a 20-year operating period that will produce renewable natural gas and fertiliser and reduce greenhouse gas emissions by up to 15,000 tonnes annually.

The project showcases a successful collaboration between GHD and Convertus, delivered using Integrated Project Delivery (IPD) with Bird Construction (Bird). GHD originated the project with Convertus, led the permitting process, and is delivering the balance of plant design work. The IPD project is being delivered in a truly collaborative fashion, with Convertus, GHD and Bird each participating in the project's success, while also transparently managing scope, schedule, budget and risk. GHD's Project Manager Ryan Loveday reports there have been improved project outcomes across the board, both on the delivery and project side, as well as from project team members involved in the process, delivering in a lean and agile manner. Convertus, Canada's largest organic waste processor, will operate the facility under a 20-year contract with the Region of York.

Designed for long-term sustainability, the plant will be solar-ready, capture stormwater for reuse, and feature advanced odour control through a photoionisation system. The captured biogas will be upgraded and injected into the natural gas grid. Digestate will be treated and then used as fertiliser.

Dr Tej Gidda, GHD's Global Leader of Future Energy, underscored the significance of the project: "This facility represents the next evolution of the organic waste industry. It brings together innovation, collaboration, and environmental performance in a way that will serve as a model for future infrastructure projects across North America. Not only is the infrastructure unique but the manner of delivery, through Integrated Project Delivery, represents a collaborative and value-added way of developing infrastructure."

The Facility is designed to process up to

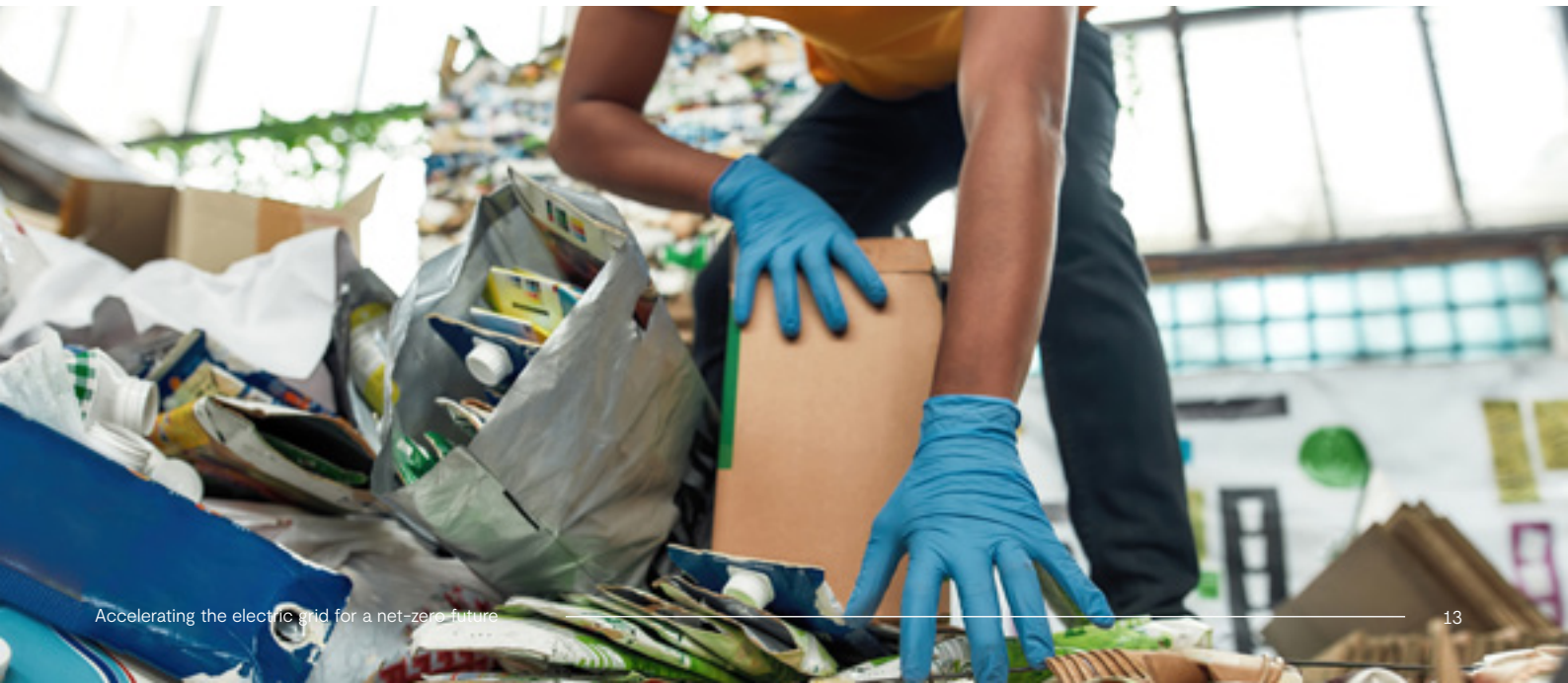
200K

tonnes of green bin waste annually, with operations beginning in early 2027.

By shifting to local processing, the York Region is expected to save

$85M

relative to existing waste contracts.



Call to action: A mandate for change

The world cannot afford to let outdated processes impede progress toward net zero. The time for incremental improvements is over – bold, systemic change is required in how we design, approve, and execute electricity transmission projects.

What needs to change?

Consider flexible delivery models as appropriate: Collaborative approaches such as IPD and Alliancing offer significant benefits and should be actively considered where conditions allow, rather than relying by default on traditional EPC models. While these alternative models are not universally applicable, moving away from a one-size-fits-all mindset can help unlock better project outcomes.

Streamline regulatory processes: Governments must fast-track permitting and harmonise regulations, particularly for cross-border projects.

Strengthen supply chain resilience: Early planning, alternative sourcing strategies, and cross-sector partnerships can mitigate material shortages.

Prioritise stakeholder engagement: Proactive, transparent communication with communities and environmental groups will accelerate project approvals and execution.

By embracing these reforms, the transmission sector can become the enabler – not the bottleneck – of the clean energy transition. This is not just about meeting climate targets; it is about building the infrastructure for a resilient, efficient, and sustainable energy future.

The path forward is clear. The only question that remains is: will we act quickly enough?

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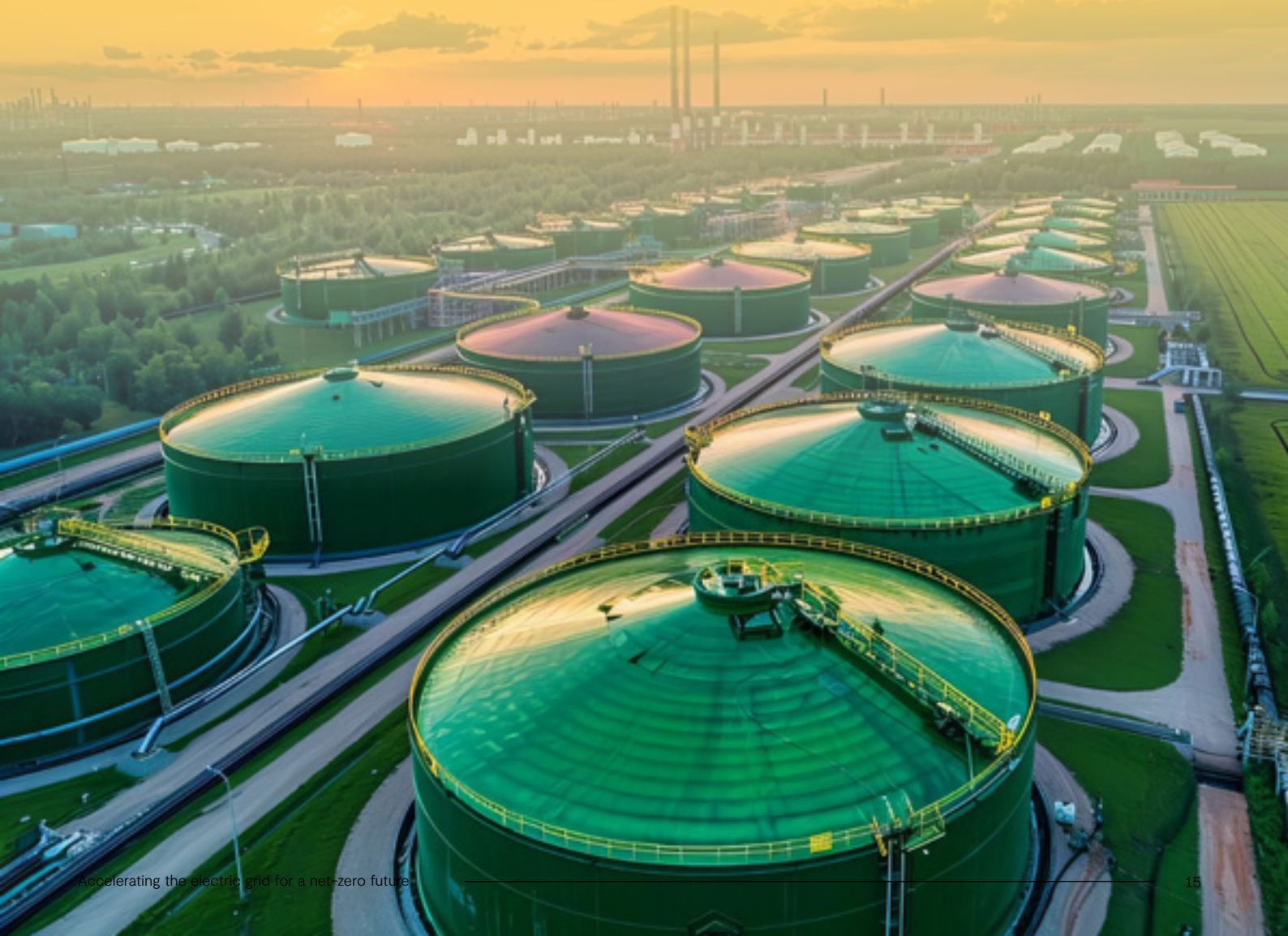

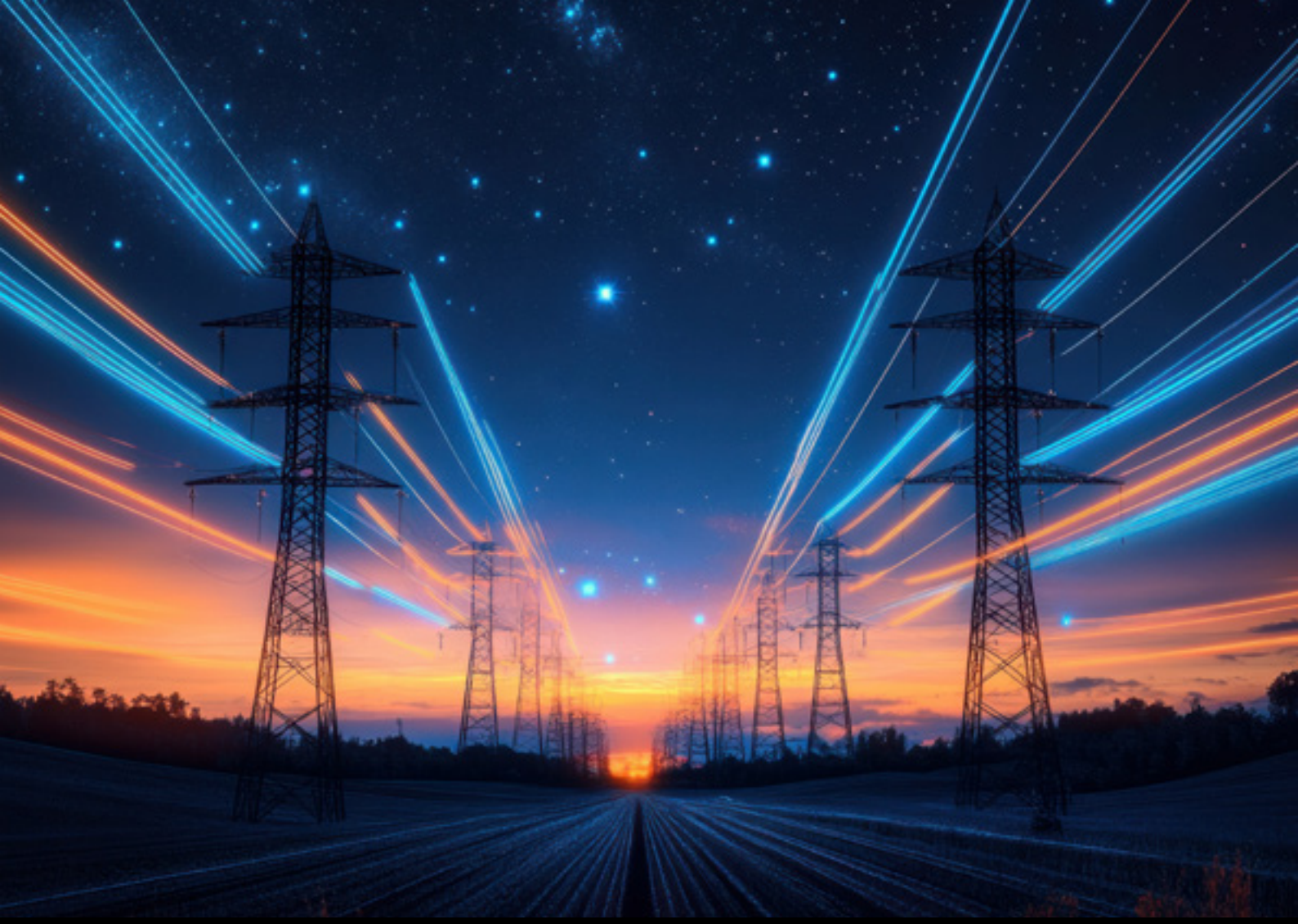

About GHD

GHD recognises and understands the world is constantly changing. We are committed to solving the world's biggest challenges in the areas of water, energy and communities.

We are a global professional services company that leads through engineering, construction and architectural expertise. Our forward-looking, innovative approaches connect and sustain communities around the world. Delivering extraordinary social and economic outcomes, we are focused on building lasting relationships with our partners and clients.

Established in 1928, we remain wholly owned by our people. We are 11,000+ diverse and skilled individuals connected by over 160 offices, across five continents – Asia, Australia, Europe, North and South America, and the Pacific region.

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