

AUSTRALIAN SECTOR BROCHURE

Energy

OPPORTUNITIES
THROUGH
EXCELLENCE

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BG
&E

Introduction

BG&E is a globally renowned civil and structural engineering consultancy celebrated for its innovative, cost-effective, and award-winning designs.

With a dynamic team spanning 15 offices worldwide - including Australia, New Zealand, South East Asia, the United Kingdom and Middle East - we unite local and international professionals to deliver practical solutions with a strong focus on constructability.

Our Clients consistently return to us, attesting to our exceptional service, responsiveness, and track record for delivering tailored solutions for technically challenging projects. The quantity and scope of engineering awards we've received acknowledge our diverse industry contributions and the exceptional quality of the services we deliver across a host of regions, disciplines, and sectors.



Energy

BG&E's aim is to be at the forefront of engineering consultancies in responding to the impacts of climate change and to contribute to the delivery of projects that enhance the decarbonisation of the Australian economy.

We have provided design services for over 50 years to numerous major transport, resources and building projects. Our skills and discipline areas are fundamental inputs to the energy sector.

We understand the scale and complexity of the challenge to achieve Australia's targets of Net Zero by 2050, notably:

- The required expenditure.
- The scale of the investment in generation and transmission infrastructure.
- The complexity of the problem in arriving at the appropriate combination of generation options.

The generation and distribution of energy is by its nature being spread geographically, from the current relatively centralised system of coal fired power stations. This has significant logistic and cost implications.

Our broad range of technical expertise adds value across the entire project life cycle in wind, solar, pumped hydro energy storage and green hydrogen - as well as delivering the transmission lines that form the spine of our national distribution network.



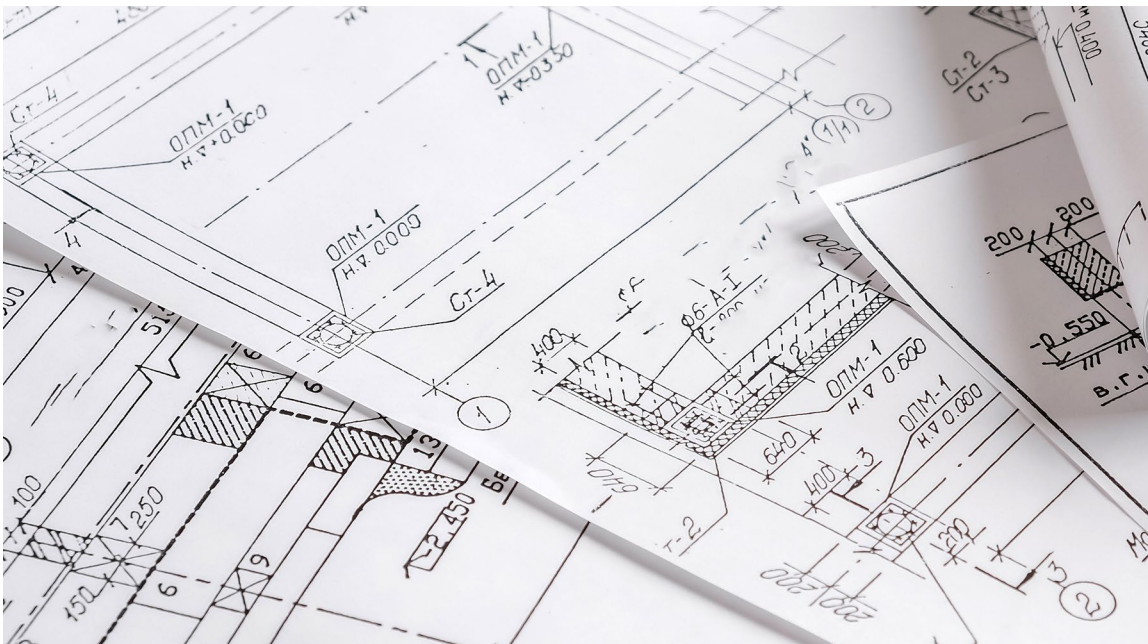
Design Services

Our client-focused approach optimises design solutions which are cost effective and constructable across the full range of power generation and transmission infrastructures.

We provide a range of civil, structural, geotechnical and environmental services (with experienced specialist partners) at each stage of the evolution and delivery of an energy project:

- Planning and approvals.
- Development application.
- Client design.
- Early Contractor Involvement (ECI).
- Detailed design.
- Design and construct.
- Construction phase support services.

As one of Australia's leading structural and civil engineers, BG&E has considerable expertise to contribute to the development, design and construction of generation, transport and transmission infrastructure - regardless of how remote the location.



STRUCTURES

- Footing and bases for various componentry and buildings.
- Miscellaneous structures.
- Service buildings.
- Structural tower design and value engineering.
- Transformer slabs.

CIVILS

- Earthworks, pads and benches.
- Internal roads.
- Foundations.
- Site establishment.

CIVIL STRUCTURES

- Bridges and culverts.
- Miscellaneous structures.
- Retaining walls.
- Temporary works.

CONSTRUCTION ENGINEERING

- Civil.
- Materials support.
- Structural.

LOCAL, PRIVATE & ACCESS ROADS

- Alignment.
- Design reports.
- Earthworks and formation.
- Intersection upgrades.
- Local authority approvals.
- Pavements.
- Road furniture and signs.
- Road safety audit.
- Services relocation.
- Stormwater and drainage.
- Swept paths.
- Traffic modelling and planning.
- Transport route confirmation.

MATERIALS & DURABILITY

- Asset management.
- Construction support.
- Durability.
- Forensic investigation.
- Specification.

FLOOD & DRAINAGE

- Drainage infrastructure.
- Flood modelling and risk management studies.
- GIS.
- Hydrological investigations.
- Integrated water management studies.

GEOTECHNICAL

- Complex foundation design.
- Design.
- Geotechnical interpretation.
- Modelling.
- Soil and structure.

DIGITAL ENGINEERING & GIS

PROJECT WIDE & TECHNICAL

- Bridges and culverts condition assessment and load rating.
- Design management.
- Digital engineering leadership.
- Durability.
- Environmental (specialist partner).
- Project management.
- Safety in design.
- Site analysis and selection (MCA).
- Site establishment.
- Siteworks.
- Traffic engineering and modelling.



Transmission

BG&E has the expertise to provide a full design service for the structural and civil aspects of transmission lines and associated infrastructure.

The designation of Renewable Energy Zones (REZs) in regional areas of Queensland (QLD), New South Wales (NSW) and Victoria (VIC) demonstrates the geographical spread and relatively remote siting of renewable energy generation, when compared to the relatively centralised traditional coal fired power stations.

Thousands of kilometres of transmission lines need to be constructed to connect the various sources of energy generation to Australian users.

Key aspects to be considered include:

- Remote locations and often difficult terrain.
- Varying geotechnical conditions.
- Access to the transmission lines and along the lines for construction and maintenance:
 - » Potential flooding impacts.
 - » Size and weight of plant for construction and maintenance.
 - » Balance of access cost for construction versus maintenance.
 - » Inadequate access.
- The benefits of repetition and modularisation.
- Tower structures and foundations and the benefits of refinement.
- Civil structures for access.
- Environmental constraints and considerations.
- Sustainability considerations.
- Site establishment.



Solar Power

BG&E’s civil and structural teams have the expertise and experience to provide efficient designs that respond to the specific needs of Photovoltaic (PV) solar array field design - including flooding, access and site grading.

Whilst solar PV energy generation only accounts for three to four percent of global electricity demand, each year more solar energy generation capacity is added than any other type of energy generation.

A key aspect of PV solar arrays is the high repetition of light weight, displacement sensitive structures. Small efficiencies in the design of foundations and support structures can lead to significant savings overall due to this repetition.

In addition to efficient design of the support structures, there is a need for:

- A large footprint.
- Relatively flat sites.
- Combined Services Route (CSR) reticulation for both power and communications requires careful consideration of earthworks design and stormwater management.



Onshore Wind Power

Onshore wind power generation is a proven technology that in recent years has seen the development of more efficient and taller towers, increased electricity generation capacity, and larger rotor diameters.

Wind generation has been Australia's major source of clean energy - comprising approximately ten percent of Australia's total energy generation, but the amount of electricity generated by wind will need to increase dramatically in the coming years for Australia to reach its renewables targets.

Onshore wind power will continue to be a major component of Australia's renewable energy generation with numerous wind farms of increasing scale under construction or being planned across Australia.

Aspects of onshore wind power in which BG&E has specific expertise are outlined below.

SITE ACCESS - PUBLIC ROADS & INTERNAL PROPERTY ROADS

Onshore wind power sites tend to be located in steep and challenging terrain. Site access - initially for construction activities, through to operations and maintenances, then ultimately onto decommissioning and rehabilitation - requires careful planning and design to ensure:

- Minimum impact on the surrounding environment with respect to clearing of vegetation.
- Impacts on natural waterways and the ability to minimise the need for expensive drainage structures, whilst reducing the concentration of storm flows that can result in increased erosion potential.
- Maintaining acceptable vertical and horizontal alignments that consider the specifics of site access (i.e. vertical grades and curve radii).
- Pavement design that is efficient and considers the exact requirements of the site – specifically in relation to available local materials, maintenance and design life.

FOUNDATION DESIGN & SOIL-STRUCTURE INTERACTION

Onshore wind power turbines are typically tall, large cantilever structures that are subject to high lateral wind loads – both sustained and transient in nature.

The efficient design of foundations for these structures requires a clear understanding of structural and geotechnical design, but more importantly a sound knowledge of soil and structure interaction.

Further, the often remote location and difficult access can impose plant and equipment limitations on foundation options.





TRANSITION RING DESIGN

Original Equipment Manufacturers (OEMs) have standard designs for transition rings to transfer loads from the turbine to the foundation. Optimising the design and correct selection of UHP grout can reduce risk and generate considerable savings.

At BG&E we liaise with our clients to provide optimal financial, structural and environmental outcomes.

We understand the constructability constraints that exposed shoulder or confined grouting design imposes. The effective bearing area between the flange and the grout dictates a homogenous load transference from the turbine to the foundation and detailed installation process must be placed to avoid air entrapment or other common application issues.

CONSTRUCTION SUPPORT

BG&E's construction engineering team can provide full support services to supplement design of the primary structures with civil and structural temporary works design.

The team can provide craneage review to optimise crane size and positioning for more cost effective construction.

The move to pre-cast concrete towers requires pre-casting in proximity of the wind farm, highly specified concrete and tight quality control, in remote locations. BG&E's leading materials team can provide specification and on-going support for quality control.

ADVANCED STRUCTURAL ANALYSIS & DESIGN EXPERTISE

Given the size of the turbines and towers plus the loads imposed, BG&E's value engineering approach, based on our structural analysis and design expertise, offers our clients the opportunity to refine the cost of construction and improve the sustainability performance of the development.

Our civil, flooding and hydrology, structures and geotechnical teams are versed in the challenges outlined above and can offer an integrated service to best address the specific requirements of onshore wind power developments. We can also provide environmental services via our highly experienced consultant partners.



Offshore Wind

Offshore wind generation is expected to grow rapidly in the coming years in Australia as wind turbines at sea take advantage of stronger, more consistent winds.

The Federal Government has declared offshore wind zones at:

- Bass Strait off Gippsland (VIC).
- Pacific Ocean off the Hunter region (NSW).

Additional zones are expected to be declared at:

- Pacific Ocean off the Illawarra region (NSW).
- Southern Ocean region (VIC and SA).

Unlike the situation in VIC and South Australia (SA), the depth of water off the NSW coast will require floating wind turbines.

The floating towers and turbines off the NSW coast will be of the order of 260 metres above water level. It is important the floating platforms remain stable, minimising any movement and ensuring that they operate under optimum conditions.

Offshore substations are often required to collect and store power close to the turbines to minimise transmission losses.

In addition, sea-bed CSR cables are required to provide connectivity to power distribution networks located on land. The design, environmental and approval process' involved with sea-bed CSR are all complex.

A major factor are the environmental considerations of de-commissioning and disposal of turbines given their 20-year life span, and the impact on the seabed and marine environment.

It is worth considering:

- The infrastructure faces significant and/or cyclical environmental forces, posing risks of fatigue and reduced performance over its lifespan.

- The manufacture and transport of components to site is complex.
- The aggressive marine environment will require highly skilled design capability.
- The complexity of maintenance of the turbines and other infrastructure.
- The foundation design (monopile, tripod, rock socket and floating).



BG&E has expertise and experience on large, complex projects with numerous constraints, including extreme loading, fatigue, access constraints and aggressive environmental considerations.



Hubs, Substations & Switch Yards

Each Renewable Energy Zone (REZ) requires at least several hubs or switchyards for switching of power from energy sources to minimise transmission losses.

Voltage transformation and distribution is maximised with substations located close to users.

These facilities can extend over large areas requiring significant site preparation and drainage.

Critical to the design are:

- Flat sites with a large footprint.
- Drainage – specifically separation of clean and dirty water and the ability to efficiently manage the clean and dirty water streams to ensure compliance with environmental legalisation and approval conditions.
- Flood immunity.
- Bush-fire protection.
- Maintenance.
- Access and egress.



Super Batteries

Large scale batteries will be a key component of the transition to a low carbon economy - providing large scale energy storage by charging during the day with available excess solar and wind power.

The power is then available to meet consumers' needs in afternoon peaks and maintain stability of the system caused by variations in wind and solar production. The batteries will also protect the grid from sudden power surges.

The challenges associated with Super Batteries are similar to those for hubs, switchyards and substations.



Green Hydrogen

Green hydrogen is increasingly seen as a key component of Australia's decarbonisation of our economy for long distance haulage, heavy industry (such as steel and ammonia production, cement and glass production), and export sales.

This source of green energy has extensive development and scale issues to be resolved before it is a viable energy.

Whilst the principles are well known, developing the commercial scale of production will involve optimising and aligning a range of key factors:

- Large volumes of water supply for cooling and hydrogen production.
- Cost of production.
- Low energy density.
- Distribution and transport costs.
- Handling.
- Cost.
- Hydrogen hubs appropriately located.
- Readily available renewable energy in large quantities for desalination of water and the electrolysis process.
- Source of electrolyzers.
- Storage-pressure and temperature.

BG&E can provide a range of civil, structural and geotechnical services to assist in the design and construction of these facilities.



Pumped Hydro

Pumped hydro energy storage along with wind, offshore wind, solar and green hydrogen will be another key component of power generation that will drive Australia's decarbonisation of our economy.

Essentially, pumped hydro energy is a configuration of two water reservoirs at different elevations that can generate power as water moves down from one to the other passing through a turbine. The system also requires low-cost renewable power during daylight hours to pump water back into the upper reservoir. Pumped Hydro Energy Storage is in effect a giant battery because it can store power and then release it when needed.

BG&E, Delve Underground and Klohn Crippen Berger (KCB) have teamed together as H3O to provide a comprehensive offering of disciplines that are of limited availability in Australia.

The team brings a combination of international and local expertise:

- **BG&E** is one of Australia's leading specialist structural and civil engineering consultancies that has supported numerous infrastructures projects internationally and across Australia.
- **Delve Underground** is a leader in tunnel design and geotechnics in Australia and North America.
- **Klohn Crippen Berger** is a Canadian, international consultants with 30 years in Australia bringing extensive experience in dams and hydropower.





The various aspects of pumped hydro energy generation and storage covered by H3O include:

- Construction phase services.
- Dam and appurtenances design.
- Durability and sustainability.
- Geotechnical services.
- Hydrotechnical (hydrology and flood routing) design.
- Intake structures.
- Outlet structures.
- Powerhouse excavation, structures and m&e interface.
- Pressure tunnels and structures.
- Surface works, access and civils.
- Temporary works – structural and civil.





Ports

We have extensive marine experience and can provide planning and design support. Additionally, our civil and traffic solutions can assist with port-to-site logistics on public and private roads.

The acceleration in the development of onshore wind and solar power generation, the coming development of offshore wind and the likely commitment to pumped hydro energy storage projects will dramatically increase the need for the upgrade of port facilities for the transport of equipment for wind and hydro turbines, towers and blades, sub-stations, transformers, synchronous condensers for construction and maintenance.

Value Proposition

Certainty of Delivery

Through our early commitment of resources in the life of a project, a 'best for project' attitude, focusing on the key issues and a collaborative approach based on strong working relationships with all stakeholders, our clients can trust in our commitment to meet program obligations.

Innovative Engineering

We are renowned for our innovative approach to our design work. Every solution is bespoke, best for project, rather than easiest for BG&E. A fundamental consideration is constructability and reducing construction time.

Collaborative Relationships

Fundamental to our success is an ability to work collaboratively with our clients, other consultants, and the multitude of stakeholders for the benefit of a project.

High Calibre and Local

We are a specialist consultancy with personnel recognised as industry leaders in their specialty areas. The **same** team will work on the tender and delivery of a project.

Management Systems

Our strong commitment to our management systems is one of the principal drivers of the provision of quality advice, design and documentation to our clients.

BG&E maintains and implements the following independently audited management systems:

<i>ISO 9001:2015</i>	Quality Management System
<i>ISO 14001:2015</i>	Environmental Management System
<i>ISO 45001:2018</i>	Work Health & Safety Management
<i>ISO 19650-2:2018</i>	Organisation and digitisation of information about buildings and civil engineering works, including BIM



Sustainability

We have capability and experience with:

- Structural embodied carbon calculation.
- Assessment of embodied carbon reduction opportunities in design.
- Greenstar rating advice.
- Infrastructure Sustainability (IS) rating scheme – major infrastructure projects are usually required to achieve a rating. We can manage ratings or assist the design team on appropriate workshops, templates, reporting in line with rating requirements.
- Sustainability services for buildings, infrastructure, precincts, and organisations include:
 - » Materiality assessment - to identify priorities and align the design, construction and client team direction.
 - » Options assessment and decision making frameworks.
 - » Sustainability in design.
 - » Sustainable procurement and supply chains.
 - » Resilience assessment and climate change risk assessment.
 - » Energy and carbon advice.
 - » Resource efficiency plans (i.e. reducing material quantities, reusing waste materials etc.).
 - » Legacy initiatives and innovation.

We use a systems-based approach which looks at the wider project and its context then considers the long term. This enables informed decision-making on pathways to improve outcomes that is not possible using more traditional approaches.

Sustainability in Design

1. PLANNING

- Can the asset (or part of it) be reused?
- What schemes are being considered, and are lower-carbon options possible?
- Early consideration of resilience risks and opportunities.

2. CONCEPT DESIGN

- Consider spans, heights, orientation and repurposing opportunities.
- Material selection.
- Proof of concept focus for innovations.
- Context versus experience.

3. DETAILED DESIGN

- Design efficiency.
- Durability.
- Deconstructability (end-of-life reuse).
- Maintenance carbon and environmental impacts.
- Material selection.
- Aesthetic choice.
- Upgrade options – new technologies, strengthening for new purpose.

4. DEVELOPMENT APPROVAL

- Design simplicity.

5. PROCUREMENT

- Material selection.
- Material re-use.
- Mix design.

6. CONSTRUCTION

- Temporary works.
- Reuse of temporary works elements.

7. OPERATION & MAINTENANCE

- Post occupancy evaluation.

8. DECOMMISSIONING

- Materials reuse.
- Materials recycling.

Digital Engineering & BIM Expertise

BG&E offers advanced digital engineering services, tailoring solutions to unique project requirements with expertise in risk mitigation, cost efficiency, and design optimisation through strategic deployment of digital engineering.



We offer a comprehensive Building Information Modeling (BIM) service using platforms like Revit and AutoCAD to enhance project efficiency and data integrity. Collaborating with stakeholders, we capture precise Project Information Requirements (PIR) and develop robust data schemas, creating a BIM that optimises data utilisation throughout the asset lifecycle.

Acknowledging the need for coordination in complex infrastructure projects, we integrate model federation and clash detection services into our BIM offerings. Our federated BIM model consolidates domain-specific models, including point cloud models, fostering superior coordination, and serving as the project's 'single source of truth'.

Addressing operational challenges, our BIM models incorporate real-time parameters, identifying spatial and operational conflicts for proactive risk mitigation. Our advanced clash detection focuses on underground utilities, minimising construction risks and delays.

To enhance project management, we help establish and maintain a Common Data Environment (CDE) complying with ISO 19650 standards. This digital repository centralises project information, facilitating standardised data handling and real-time collaboration among stakeholders.



At BG&E, we are united by a common purpose – we believe that truly great engineering takes curiosity, bravery and trust, and is the key to creating extraordinary built environments.

Our team of more than 1100 highly skilled people, in offices across Australia, New Zealand, South East Asia, the United Kingdom and Middle East, design and deliver engineering solutions for clients in the Property, Transport, Ports and Marine, Water, Defence, Energy and Resources sectors.

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