GHD is one of the world’s leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, architecture, environmental, advisory, digital and construction services to private and public sector clients.

Established in 1928 and privately owned by our people, GHD operates across five continents – Asia, Australia, Europe, North and South America – and the Pacific region. We employ more than 10000 people in 200+ offices to deliver projects with high standards of safety, quality and ethics across the entire asset value chain. Driven by a culture of client service excellence, we connect the knowledge, skill and experience of our people with innovative practices, technical capabilities and robust systems to create lasting community benefits.

With a workplace rich in diversity of thought, background and experience, we have what it takes to deliver amazing outcomes for our clients.

Committed to sustainable development, GHD improves the physical, natural, and social environments of the many communities in which we operate. We are guided by our workplace health, safety, quality, and environmental management systems, which are certified to the relevant international standards (ISO and OHSAS).

In alignment with the global demands of water, energy and urbanisation, our aim is to exceed the expectations of our clients and contribute to their success.

- Designing **world-first** hydrogen energy supply chain pilots in Australia
- Investing in global research to realise a **zero** emissions clean hydrogen energy future
- **20+** hydrogen energy projects across **4** continents
- Working across **key hydrogen sectors** to decarbonise power generation, transportation, and industrial applications.
GHD provides hydrogen services around the globe

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www.ghd.com/hydrogen
Our service offering

Practical technical experience

We pride ourselves on being a no-fuss partner to our private and public sector clients to deliver services that contribute to a thriving new clean energy future based on deep technical and regulatory knowledge.

These projects cover many aspects of hydrogen systems, from production to application, including:

- **Hydrogen Production** – coal gasification, electrolyzers (PEM, Alkaline and research), steam reformation and thermal devolution
- **Hydrogen Storage** - stationary (to 90 MPa), trailer mounted (to 25 MPa) and cryogenic
- **Applications/ End use** - Power 2 Gas, Power 2 Ammonia, hydrogen mobility (vehicle systems) and hydrogen use in Industry.

Services

We are supporting the hydrogen industry by developing:

- Economic assessments
- Engineering and design
- Logistics & Transport
- Planning and approvals
- Strategic communication, perceptions testing, stakeholder engagement and community consultation
- Hazardous area compliance
- Compliance with current safety standards and identification of ambiguities in Australian hydrogen standards
- Regulatory economics.

Partnering with universities and hydrogen industry bodies – Canada and the US

Globally and locally, we have partnered with a number of universities, industrial companies, associations, vendors, consultants, and laboratories to conduct leading edge research projects in the area of hydrogen deployment, production, distribution, and use.

GHD has and is initiating many of these collaborative studies, provided in kind services to support them, and helped apply for government funding where needed. Our team provides practical engineering and sound science evaluations of research concepts to determine what approaches and technologies work in the real world. Results from the studies are being collaboratively presented globally at seminars, conferences, and through publications so that lessons learned can help guide industry and governments in the evolving hydrogen landscape.

The following studies are some of the research projects currently in process or being developed:

- Hydrogen generation from organic waste
- Hydrogen generation from landfill gas
- Brown, blue, and green hydrogen generation technologies
- Synthetic gas (syngas)
- Industrial hydrogen/fertilizer production
- Novel hydrogen land and water transportation modes
- Synergies with renewable energy operations
- Supplement to diesel and other fuels

We partner with our private and public sector clients to deliver an alternative and clean energy future based on deep technical and regulatory knowledge and experience.
The GHD difference

Global firm providing decarbonisation solutions

Countries all over the world face significant challenges to address energy security and reduce its emissions as part of a global push to tackle climate change. Hydrogen is now seen as the clean energy commodity of the future due to its versatility in power generation, storage and zero emission fuel cell vehicles.

GHD is proud to be working on many of the current hydrogen studies and supply chain projects underway across Australia, Canada and the UK. We draw from the expertise of colleagues across our global technical teams and leverage our deep experience in the development of similar fledgling industries.

Shaping government policy – Australia and Canada

GHD is the only multi-disciplinary consulting firm to participate in industry workshops to develop the Australian National Hydrogen Strategy and the Canadian Government’s H2GO Strategy.

We acknowledge there is an exciting and unique opportunity to develop a new clean hydrogen energy export market leveraging Australia’s high value renewables resource position to respond to unprecedented momentum and potential growing global demand for hydrogen. Many of our technical leaders provide their time in-kind to be part of the conversation.

Hydrogen 101 – its role in global decarbonisation

On Earth, hydrogen is virtually non-existent in its free form. Energy must be used to liberate it from the material forms in which it exists, such as water, biomass, minerals and fossil fuels.

Currently, the most common production methods are to split water molecules into hydrogen and oxygen using electricity, or through a thermochemical reaction using fossil fuels. The energy to produce the hydrogen is released at the point of use. As such, hydrogen is technically an energy carrier or vector rather than an energy source.

Hydrogen is an excellent carrier of energy, with each kilogram of hydrogen containing about 2.4 times as much energy as natural gas. This energy can be released as heat through combustion, or as electricity using a fuel cell. In both cases the only other input needed is oxygen, and the only by-product is water.

Hydrogen is unique among liquid and gaseous fuels in that it emits absolutely no CO2 emissions when burned. From a consumer perspective, hydrogen is a gas much like natural gas that can be used to heat buildings and power vehicles.

Hydrogen is the simplest and most abundant element in the universe. As an atom, it consists of one electron and one proton. As a molecule (H2), it is a colourless, odourless, non-toxic gas.

For hydrogen to decarbonise energy systems and industrial processes, it must be produced using renewable electricity or from fossil fuels with carbon capture and storage (CCS).
Hydrogen Energy Supply Chain Project, Victoria
Kawasaki Heavy Industries and JPower, 2016 to ongoing
A consortium of Japanese companies is aiming to prove the various supply chain elements to enable hydrogen fuel to become a commercially viable fuel in Japan in the future. KHI and JPower are leading the initiative in a world-first attempt to convert Victorian brown coal into hydrogen for open-sea transport (export) in a liquefied form, with significant funding support from the Australian, Victorian and Japanese Governments.

This requires:
• Pilot-scale coal gasification and syngas refining in the Latrobe Valley, using a high moisture brown coal feedstock,
• hydrogen transport by road to a port terminal where it is liquefied and stored for export by sea loading of hydrogen onto specialised ships and transport to Japan

We are providing a range of engineering, planning and environmental services to the project consortium:
• Site selection studies
• Approvals and permitting, including Works approval
• Communication, stakeholder engagement and website development
• Leading on licensing and environmental approvals
• Safety systems design and Australian compliance, including hazard identification, HAZOP facilitation, fire & gas detection design
• Process mass balance, detailed civil, structural, mechanical, electrical and control system design and procurement assistance for the pilot scale plant in Latrobe Valley
• Technical (owners engineering) assistance.

Hydrogen to support electricity systems
Department of Environment, Land, Water and Planning Vic, 2019
GHD, in partnership with ACIL Allen, provided advice on COAG Energy Council’s development of a National Hydrogen Strategy via the ‘Hydrogen to support electricity systems’ work stream.

This work stream focuses on understanding the interactions between hydrogen and Australia’s on-grid and off-grid power systems.

The project team undertook an extensive literature review that considered demonstration projects and barriers to hydrogen production and use internationally, developing learnings for Australia’s electricity sector. The team also looked at the way that hydrogen production technology could provide benefits to Australia electricity networks. A series of regulatory and policy options were identified that would help electricity markets realise these benefits from the hydrogen sector, as that sector matures.

The team considered the potential for hydrogen opportunities to emerge in the NEM, SWIS, NWIS and NT interconnected networks with consideration of the physical network characteristics and the markets that may provide future revenue streams for hydrogen producers that rely on power as an input to produce clean hydrogen. The team also developed a series of use case scenarios that considered different network configurations and isolated power system applications. Through these case studies a series geographical, physical, technical and economic considerations were identified, as well as indicative deployment timeframes based on these factors.

Assessment of Hydrogen Value Chain Options for 10-25 MW Electrolyser System / Stanwell Energy
We undertook a study to determine the preferred value chain for hydrogen production based on a 10-25 MW electrolyser. The host site was considered to already have power generation capability.

The study considered four potential uses for the hydrogen:
• Being compressed and loaded into tube trailers for sale to third parties
• Being used to produce ammonia and loaded into road tankers for sale
• Being used to produce power
• Being used to produce heat within the existing plant

Our study considered a number of alternatives to identify preferred technologies and economies of scale. These included:
• Power interconnection options
• Alkaline and PEM electrolyser
• 3 MPa and 25 MPa storage (steel bullets and aluminium tubes)
• Two technologies for micro ammonia plants
• Gas turbines and fuel cells for power generation
• Two heat integration options
• Two hydrogen truck dispatch scenarios.

The study identified viable value chain pathways from the above options and, for these pathways, evaluated the plant requirements, storage volumes, compression requirements, power and water supply, performance, capital costs and operating costs. A SWOT workshop was also undertaken to identify qualitative advantages and disadvantages. The client combined the provided information with current and future market price information to produce preliminary business case models and to identify a preferred pathway.
Our work - Australia

1. Yara / Engie: Western Australia 100 MW Solar > Hydrogen > Ammonia Plant
2. JPower and Kawasaki Heavy Industries: Hydrogen Energy Supply Chain Project
3. AGIG: Located at the Tonsley Innovation District, Hydrogen Park South Australia (HyP SA) is an innovative project that will produce renewable hydrogen gas
## Ammonia to Hydrogen membrane cracking technology
*Commonwealth Scientific and Industrial Research Organisation (CSIRO)*

We undertook an Ammonia to Hydrogen membrane cracking technology pre-feasibility study to take this concept to the next stage of development. This is a significant project which has led to vast opportunity to scale up the production of hydrogen from ammonia leading to a range of new applications for the development of a hydrogen industry for Australia.

## Technical and commercialisation review of innovative electrolyser technology developed in Australia
*ARENA*

We undertook a review of a detailed funding application to enable the continued development of an innovative electrolysis technology. The technology had been invented in a university and a dedicated company had been set up to further develop and then commercialise the technology and the associated manufacturing process.

The review considered:
- The current and projected performance improvements of the technology.
- The current and projected cost reductions due to improvements, increased scale and improved manufacturing processes.
- Current and projected performance and costs of existing electrolysers using PEM and alkaline technology.
- The commercialisation timetable for various market applications and key trigger points.

## Hydrogen Demonstration Project FEED Study
*Jemena*

We developed a Front End Engineering Design study for a hydrogen demonstration and test facility in NSW. The facility included electrolyser hydrogen production, hydrogen compression, storage, vehicle refuelling, power to gas injection to a local natural gas distribution system, fuel cell power generation, a research building and a combined operation and education building. We prepared key design documents including the design basis manual, site layout, PFD, P&IDs, control system architecture diagram, electrical single line diagrams, hazardous area diagram, electrolyser specification, equipment datasheets and building layouts. We prepared a cost estimate based on vendor pricing, material take-offs and factored indirect costs.

## HyP SA Hydrogen Facility Concept Study, South Australia
*Australian Gas Infrastructure Group (AGIG)*

We undertook a review of initial options and high level costs for a hydrogen facility at Tonsley Park. The initial schemes included 10MW or 1.25MW electrolysers, PV power supply, power to gas injection, bus and vehicle fuelling station and a tube trailer filling facility. GHD then prepared a concept study and cost estimate for the staged development of an initial power to gas using a 1.25MW electrolyser, with subsequent additions of a behind the meter PV supply, local power network connection, gas reticulation injection system and a tube trailer filling facility.

## HyP SA Demonstration Project FEED Study, South Australia
*Australian Gas Networks*

Australian Gas Networks (AGN) has engaged us to prepare a FEED study for the proposed HyP SA project at Tonsley Park in Adelaide. The former Mitsubishi Motors assembly plant at Tonsley is in the process of being completely redeveloped as an integrated employment, education and residential precinct by Renewal SA. It is Australia’s first innovation district, connecting businesses with the best and brightest. The HyP SA project will be one of several innovation projects being developed by industry with support from the Government of South Australia.

The project will be based on a 1.25MW electrolyser and will include a gas injection facility for blending hydrogen into the natural gas network. The project will also allow for future expansion of a second gas network injection point, tube-trailer filling facilities, and connection to a solar power plant located on the Tonsley site.
Our work - Australia

100 MW Solar > Hydrogen > Ammonia
Yara / Engie

We provided key inputs into a feasibility study with the goal of designing a green hydrogen plant that would be integrated with Yara’s existing ammonia plant in Pilbara, Western Australia. The goal is to transform the plant from one that relies completely on natural gas for hydrogen to one where a significant share of the hydrogen comes from renewable power.

Power to Ammonia Concept Study - Renewable Hydrogen
Confidential Client

GHD prepared a concept study and cost estimate for a small demonstration plant to generate ammonia using renewable energy. Hydrogen would be generated by electrolysis using electricity from pv array. The hydrogen produced would then be integrated with an existing plant generating ammonia using the Haber-Bosch process.

The concept study considered a number of sizing combinations and identified integration issues.

Renewable Hydrogen/Ammonia Export Project
Confidential Client

GHD carried out a study to investigate the technical requirements and economic viability for a renewable ammonia export facility for a confidential client. This study included a process involving desalination of sea water, producing demineralised water, producing hydrogen using PEM electrolysis technology, using an air separation unit (ASU) to produce nitrogen and delivering nitrogen with hydrogen to an ammonia synthesiser to produce renewable ammonia. Storage and handling facilities at the port were also included in the study.
Our work - North America

Waste To Energy - Hydrogen Production
North America
GHD is providing engineering and other services to a large waste to energy client for a hydrogen production and distribution project. The project involves multiple grant applications for the project, engineering design, permitting and construction management, and distribution and marketing planning. The hydrogen facility includes electrolyzers, compression, pipeline distribution, private and public fueling, and tube trailer loading and decanting.

Hydrogen Roadmap
North America
GHD has provided technical, business, and market experience to develop a strategy plan that will be used to develop a federal hydrogen deployment roadmap for Canada. GHD will be a stakeholder in the roadmap development process to support a practical and meaningful plan to grow the hydrogen market similar to other countries such as Japan, Germany, U.K. and Australia. GHD also has provided input in to the evolving strategy plan for Australia.

Hydrogen Pipeline Permitting
North America
GHD assisted a major supplier in developing preferred routings, permitting, and construction of a number of hydrogen pipelines in the southern US. Extensive support was required to support federal environmental permitting through wetlands and sensitive areas, including one pipeline section installed beneath a lake. Our services involved design review, preparation of permit applications, and support for permit negotiations.

Power to Ammonia Study
Global
GHD prepared a concept study and cost estimate for a small demonstration plant to generate ammonia using renewable energy. Hydrogen would be generated by electrolysis using electricity from pv array. The hydrogen produced would then be integrated with an existing plant generating ammonia using the Haber-Bosch process. The concept study considered a number of sizing combinations and identified integration issues.