AECOM

Statement of Qualifications for

Hydrogen

Fueling the Future

aecom.com/ca

Delivering a better world

Sustainable Legacies

The world's growing need for reliable electricity puts added pressure on the global power industry to develop cleaner, more efficient solutions. AECOM's integrated approach delivers full life-cycle support to help clients meet those challenges.

With close to 52,000 employees around the world, we have established ourselves as trusted advisors — planners, designers, engineers, consultants and program and construction managers. AECOM can design, engineer, construct, decommission, retrofit and maintain virtually every type of power plant, as well as the systems that transmit and distribute electricity – worldwide.

AECOM — delivers sustainable legacies by helping the world transition to a low carbon energy model. We work with utilities, clients, governments, regulators and investors, we help clients make choices that are right for them at each stage of their journey — from vision to strategy and stakeholder engagement, through to permitting, design, deployment and integration, and delivery. AECOM offers client services and solutions addressing changes in power generation, modernization of the electric grid, shifting to low and no-carbon fuels, and understanding how, where and when energy is consumed.

Sustainable Legacies is AECOM's strategy for reaching ambitious ESG objectives. This strategy integrates four key pillars that will embed sustainable development and resilience across our work, improves social outcomes for communities, achieves net zero carbon emissions, and enhances governance. AECOM is committed to publicaly reporting on ESG pillars as we work to enhance performance in the most responsible manner possible.

- Embedding Sustainable Development
- Improving Social Outcomes
- Achieving Net Zero Carbon Emissions
- Enhancing Governance

With Environmental, Social and Governance (ESG) principles embedded in everything we do, the goal of our Sustainable Legacies strategy is straightforward: to ensure that the way we run our business, and the work we do in partnership with our clients, leaves a positive, lasting impact for communities and our planet.

We see Carbon Capture Storage and Utilization technologies as an important part of the transition towards a sustainable Net Zero society.

Why Hydrogen

Clean hydrogen is a compelling complement to a fully decarbonized energy system

As an energy-dense storage vector for both heat and power with no direct harmful emissions, hydrogen and its derivatives provide a diverse range of uses to enable the energy transition.

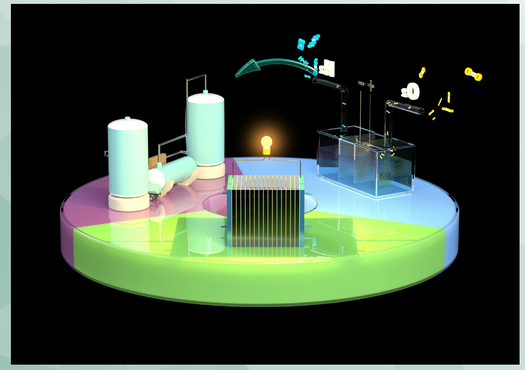
As a society looks to decarbonize, it is becoming clear that electrification alone cannot solve all of our energy utility requirements.

In areas where energy cannot be cost-effective locally generated, stored by other means, transferred by wire to where it is needed or where significant heat is required, the versatility and technical feasibility of clean hydrogen as a gaseous/liquid fuel is becoming an attractive clean alternative to carbon-based energy sources.

AECOM not only advises clients on how to make this transition safely and economically, but as leaders in the field of deployment of complex infrastructure, we facilitate the transition to the right solution safely, cost-effectively and in a manner that does not compromise existing business operations.

Hydrogen Production

AECOM has a deep bench of engineers that have completed conceptual designs to detailed engineering for hydrogen compression and storage, steam systems, power generation, and other balance of plant utilities.



Hydrogen has been manufactured from fossil fuels for decades and there are established procedures for compressing, storing, and transporting it. Green hydrogen electrolyzed from water and zero emission when powered by 100% renewable sources, has yet to be commercialized at scale. Green hydrogen is an emerging zero emission energy source that will be a key fuel to support decarbonisation. The situation is moving fast with electrolyzer manufacturers in the US, Western Europe and China vying on product, production capacity and project size on an almost weekly basis. Successful project delivery will require these new electrolyzers to be safely integrated into hydrogen storage and transport systems.

Our Approach

AECOM has completed numerous feasibility studies for new process technologies involving hydrogen production, gas processing, and CO2 capture; these have informed national government policy, in support of our large oil and gas clients, or to inform the thinking of innovative private developers.
We recently completed a white paper about green hydrogen production from solar power for a developer to better understand the pathway to developing such a facility. The paper covered the technical production aspects, process safety, permitting, and reporting. Technical considerations included solar power generation profiles, electrolyzer selection and performance, water demand, wastewater, and hydrogen compression, storage, and transportation. Process safety considerations included PSM (OSHA requirements), flaring hydrogen, safely venting oxygen, and electrical area classification. Environmental sections included the applicable permits and regulations that would apply to a green hydrogen facility in California.

Areas of Expertise

HYDROGEN SAFETY. For AECOM, the delivery of safe hydrogen projects is core and we have a very active Process Safety Management team with years of hydrogen experience. This experience is critical as we expect to see green hydrogen projects in environments with little or no prior risk exposure to fuels such as hydrogen.

HYDROGEN TRANSPORTATION. Projects will require an extensive expansion of hydrogen transportation infrastructure including pipelines and shipping. AECOM has an experienced pipeline group that can support evaluations of hydrogen pipeline infrastructure; they have delivered numerous hydrogen plant and pipeline designs in the Gulf Coast of the U.S. associated with refineries.

HYDROGEN STORAGE. Subsurface gas storage is a component of the hydrogen ecosystem. AECOM has designed pressure control stations to assess gas withdrawal flow rates that meet the design conditions at all field pressures, to include the late season reduced storage pressures. In addition, we can help developers and operators manage risk to stored hydrogen stability from the presence of sulphides, carbonates and other impurities that may be in the existing geosphere and could potentially create instability of the storage cavern or the stored hydrogen.

HYDROGEN USE CASES. As volumes of supply increase, green hydrogen will have many uses. We have evaluated hydrogen use business cases in many applications such as: the rail industry, for peaking power, both as pure hydrogen and mixed with natural gas; for heavy goods logistics; and the role that electrolysis can have in decarbonizing the water industry. One such example is support to hydrogen and battery traction trials in the UK where we developed the business case assimilating asset lives, rail infrastructure network characteristics, technological advances, and key contractual insertion points. We supported the client, the UK Department of Transport, in bilateral discussions to understand the supplier landscape, appetite and readiness to perform trials, and helped develop trial specifications of new instructions for bidders and contract development.

Advisory Services for Hydrogen

As agnostic experts in the deployment of hydrogen technologies, we help appraise the suitability of decarbonized energy models and then facilitate the transition to the right hydrogen solution safely, cost effectively and in a manner that does not compromise existing business operations.

Our Approach

As the world's trusted infrastructure consulting firm, AECOM seeks to partner with clients to solve the most complex challenges and build sustainable legacies for generations to come. We are creating jobs, enabling the energy transition and improving the world in which we live.

AECOM is not a producer, handler or direct user of hydrogen. We enable clients to evaluate, develop and deliver the benefits of integrating hydrogen seamlessly across a suite of decarbonized energy solutions into existing and future infrastructure.

Key AECOM Attributes

- Proven ability to develop business case development for hydrogen projects and implement on an integrated basis on behalf of clients (design, consenting, procurement, project management, commissioning and handover).
- Leaders in deploying complex infrastructure, developing regulatory guidance / operating standards, and engaging stakeholders successfully.
- Focus on enabling and interface works and work in partnership or as owners engineer to manage process technology for production / utilisation. Additional capabilities in water / waste for complete solution
- Tailored offering from advisory through design into procurement and construction management.

INVESTMENT DECISION → OPPORTUNITY → DESIGN → PROCURE → CONSTRUCT → OPERATE → DISPOSAL

MOBILITY

Proven EPCM credentials in hydrogen storage and dispensing to full suite of transit customers and energy providers

PRODUCERS

Market leading permitting excellence, enabling new developments inclusive of all supporting infrastructure and tie ins (including renewable generation/electric infrastructure links/CCUS/ process water). Supporting FEED/OE role for delivery of hydrogen and associated intermediaries

HUBS

Networks of clean hydrogen producers, connective infrastructure and consumers enable the adoption of hydrogen and fuel cell technologies for transportation, power generation, and more.

Areas of Expertise

WRITING THE STANDARD. As leaders in the field of deployment of complex infrastructure, we are developing regulatory guidance and operating standards for the manufacture, transportation and use of hydrogen (and hydrogen carriers such as ammonia). This position puts us in ideal place to share global best practice and deploy these standards efficiently. We are able to engage stakeholders successfully and understand the implications of adoption by ultimate clients and associated incentives for doing so.

ADVISING ADOPTION. AECOM helps clients understand if hydrogen (or an alternative) is the right solution to their specific challenge. We develop business cases for hydrogen projects, informed by our track record of implementing comparable projects on behalf of our customers. We draw down our design, consenting, costing, procurement, project management, commissioning and handover skills to understand and mitigate risk. Our ability to understand the synthesis of economic, social and environmentall considerations of new industries combined with our engineering pedigree guides our stakeholder engagement process successfully.

TECHNOLOGY AGNOSTIC EXPERTS. AECOM is not a producer, handler or direct user of hydrogen. We enable customers to evaluate, develop and deliver the benefits of integrating hydrogen seamlessly across a suite of decarbonized energy solutions into existing and future infrastructure. As agnostic experts in the deployment of technology, we help appraise the suitability of decarbonized energy models facilitating the transition to the right solution safely, cost effectively in a manner that does not compromise existing business operations. We align the enabling infrastructure requirements of developments for optimized operation of all forms of hydrogen projects.

PROJECT DELIVERY PARTNERSHIPS. AECOM can act as your delivery partner across the lifecycle of hydrogen projects. We provide end to end advisory, project development and delivery services for infrastructure requirements on an integrated basis. Our global hydrogen engineering centre of excellence provides cost effective expertise to our local design teams. Our knowledge of the supply chain informs our world renowned procurement, project management and construction management teams to commission and deliver a full range of hydrogen infrastructure safely where it is needed.

PRODUCTION TO UTILITY CAPABILITY. AECOM has successfully enabled some of the world's leading clean hydrogen production facilities from electrolytic combination with offshore wind and hydropower to integrated chemical synthesis of hydrogen with associated carbon capture and storage technologies. AECOM has a particular pedigree in decarbonization of transport systems and the associated hydrogen mobility infrastructure.

STRONG PUBLIC AND PRIVATE SECTOR RELATIONSHIPS. Through our strong public and private sector relationships we are focussed on successfully positioning hydrogen hubs and delivering the full spectrum of integrated infrastructure requirements.

AECOM Focus Infrastructure

- Feed Source / Supply
- Production (Blue/Green/etc.)
- Biproduct Utility/Storage
- Storage / Distribution
- Utility – Mobility/ Heating/Energy

Enabling Infrastructure/ Balance of Plant for Hydrogen

From the early planning stages through to construction, we combine our broad global reach with our strong regional presence to implement industry best practices and deliver effective local solutions across the entire life cycle of vital hydrogen infrastructure.

Our Approach

Around the world, AECOM plans, engineers and oversees construction on complex and essential hydrogen transport and manufacturing infrastructure. With more than 80 years of infrastructure design and development experience, we've gained an in-depth understanding of the infrastructure industry and its intricate commercial and policy drivers. We work with some of the world's leading public and private organizations, helping them deliver hydrogen infrastructure.

Experience

We focus on supplying the applicable subject mater experts to deliver successful projects around the world. We have a large portfolio of experience that includes due diligence, planning, design, engineering and construction projects across a range of locations and facilities worldwide. We collaborate with our clients to provide high-quality, well-managed professional services that meet their program and budget goals.

Transforming Innovative Ideas Into Real-world Solutions

Our client relationships are built on an appreciation of business needs and a proven record of innovative and cost-effective project development. From the early planning stages through to construction, we combine our broad global reach with our strong regional presence to implement industry best practices and deliver effective local solutions across the entire life cycle of infrastructure.

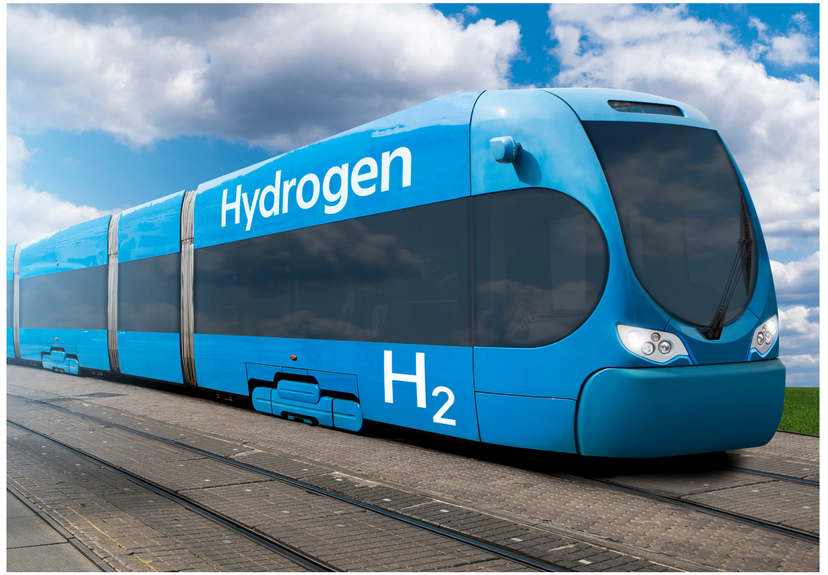
Key AECOM Attributes

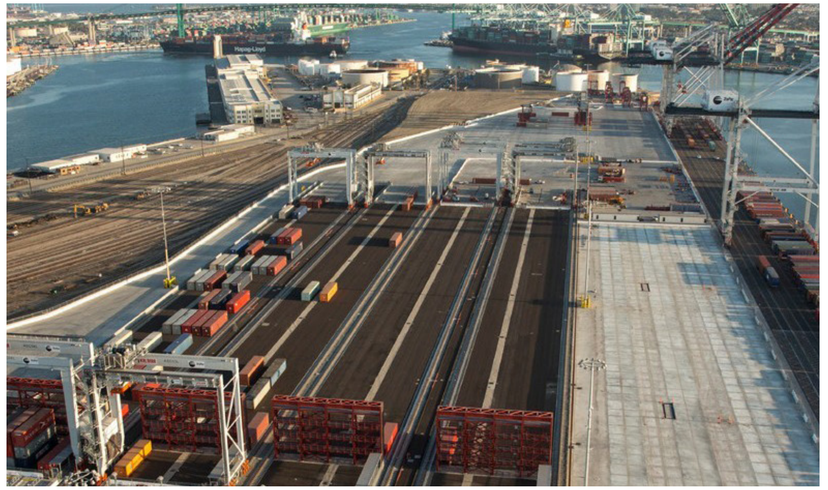
INNOVATION IS KEY when it comes to hydrogen projects. Our approach enables us to achieve unique, safe solutions based on industry best practices throughout the entire project life cycle.

Our engineers, planners, simulation and logistics specialists, architects and economists are at the forefront of energy, industrial, pipeline and transportation trends. We've built our reputation on incorporating new technologies in projects throughout the Americas.

Areas of Expertise

- Strategy & Planning
- Engineering & Design
- Construction
- Operations & Maintenance
- Decommissioning & Closure





Environmental Permitting and Planning for Hydrogen

Services

- Siting, Project Feasibility and Permitting Strategy
- Digital Engagement (PlanEngage) Digital Data Management and Data Capture
- Environmental Policy Development
- Environmental/Social Impact: EIA/EIS/ESHIA/CEQA/NEPA/SEPA
- Air Quality Assessment
- Baseline Field Studies/Ecology
- Project Permitting Program Management
- Environmental Mitigation, Monitoring and Planning
- Regulatory Permitting/Negotiation
- Traditional and Virtual Stakeholder/Public Engagement
- Visual and Noise Impact Assessment, Modeling
- Fate and Effects Transport/Dispersion Modeling

AECOM leads the market in securing license to operate for hydrogen projects having managed over 50 planning, construction and operational permits in the sector.

We have successfully obtained the first ever consent order for both subsurface CCS sequestration and for a full chain gas-fired power plant capture system in the UK. In undertaking these projects, AECOM helped define Best Available Techniques for the sector including helping to draft regulatory guidance.

Our global teams are actively supporting hydrogen projects across the Americas, Europe and Asia Pacific, leveraging best practice and regulatory engagement strategies. This includes providing permitting, consenting and engineering support at the world's largest CCUS project in Louisiana, U.S.

AECOM combines permitting and engineering services and expertise together in-house.

EPCM Services for Hydrogen

AECOM's expertise drives success and cost savings in engineering, procurement, and construction management (EPCM) projects.

Across all components of the project cycle — pre-project planning (i.e., FEED) studies, design, build, finance, and operate — we are uniquely positioned to deliver a differentiated service, working globally and delivering locally. As a trusted partner, we draw together teams of engineers, planners, subject matter experts in geotechnical engineering, project and program managers, environmental specialists, technology providers, permitting specialists, cost and schedule specialists, consultants, procurement specialists, and construction specialists — all dedicated to finding the most innovative and appropriate solutions for our clients. Whether we serve clients at one phase of the project lifecycle or throughout it, our role is to apply creative vision, technical expertise, interdisciplinary insight, and local experience to address complex challenges in new and better ways.

AECOM's vast expertise in engineering, procurement, and construction provides our clients with a full-services-aligned approach for development and operations. We offer a full suite of services, including engineering, feasibility studies, permitting, procurement, logistics, project control, construction, and operations services, all geared to ensure timely and efficient project execution.

Our Approach

AECOM's construction experts provide clients with an extensive range of pre-construction and construction-related services and solutions for projects of varying scope, budget, schedule, and complexity. As a project progresses – or increases in complexity – we customize our services to fit each client's unique needs and requirements. Our suite of services covers every aspect of a client's project, from planning to completion.

Pull Planning

AECOM's success in project delivery results from our focus on aligning the project activities with our client's goals. This alignment happens through extensive pre- project planning activities that begin many of our projects. The primary pre-planning activity consists of a "pull planning" session with AECOM and client participation. Through this session, the team develops the overall roadmap for the project, illustrating how the key activities and milestones will fit together to meet the project objectives. The roadmap evolves into a project work plan and schedule, providing a clear vision of the path to project success.

Areas of Expertise

PROCUREMENT

- Supply Chain Optimization
- Developing, Implementing, and Managing Procurement Plan
- Strategic Sourcing

CONSTRUCTION/CONSTRUCTION MANAGEMENT

- Constructability reviews
- Value engineering
- Cost estimating
- Scheduling and pull planning
- Sustainability strategizing and implementation
- Bid package preparation
- Procurement/Expediting/Logistics
- Document control
- Bid evaluation
- Field planning/supervision
- Safety programs/supervision
- QA/QC
- Closeout and warranty procedures
- Cost engineering and control
- Building commissioning
- Logistics planning
- Materials and equipment receiving and reporting
- Field construction engineering
- Surveying
- Contract administration
- Field trouble shooting
- Estimating
- Startup and commissioning

Health and Safety Excellence

AECOM places the highest priority on the protection of safety and health of our employees, contractors, and stakeholders. Our safety culture is rooted in behavioral-based safety, both on and off the job, to ensure our safe practices complement our safety goals. We achieve sustainable safety excellence by commitment through the entire organization, from our chief officers through to our field teams:

- LEADERSHIP COMMITMENT Safety is the foundation of how we work in the field, at our project sites, and in our offices.
- BEHAVIOR-BASED SAFETY Our culture is rooted in a behavior based safety program, both on and off the job.
- Training – Safety and quality training are delivered starting on the first day of employment, then reassessed and renewed annually.
- CONTINUOUS IMPROVEMENT DRIVEN BY RESULTS Our Culture of Caring and Safety for Life Program enables us to proactively and aggressively identify, manage and elininate hazards, and reduce risk. These incident prevention efforts have continued to advance our journey toward a "zero" incident culture.

AECOM's procurement model is centralized, collaborative and data-focused, designed to optimize our supply chain.

AECOM's procurement strategy takes a programmatic approach when procuring for single scope, higher scarcity, higher value services and engineered equipment, and a category approach where there is a clear pattern of heavy use across our large and diverse global portfolio. Both approaches are supported by a highly competitive, disciplined, strategic sourcing process supported by a collaborative team comprised of experienced technical leads and procurement professionals to ensure AECOM is delivering best overall value to our clients.

This collaboration — combined with a disciplined, data-driven sourcing strategy, rigorous supplier accreditation process through our subcontractor pre-qualification and management tools, and clearly defining our award criteria based on client objectives — increases the likelihood of a smaller, well managed supply base, leveraged economy of scale, reduced commercial risk, more fixed pricing, reduced acquisition costs, greater buying specialization and more effective price negotiations. We believe leveraging both a programmatic and category approach delivers a balanced procurement strategy that capitalizes on AECOM having one of the strongest buying positions in the global design and consulting service industries.

DEVELOPING, IMPLEMENTING, AND MANAGING PROCUREMENT PLAN AECOM's diverse portfolio consists of tens of thousands of projects across our global geographies and business lines. This volume of work has lead to the development and implementation of a menu of standardized procurement plans based on our client's needs. In addition to planning, our team of experienced procurement professionals can be deployed to manage end-to-end direct procurements as an agent to our clients.

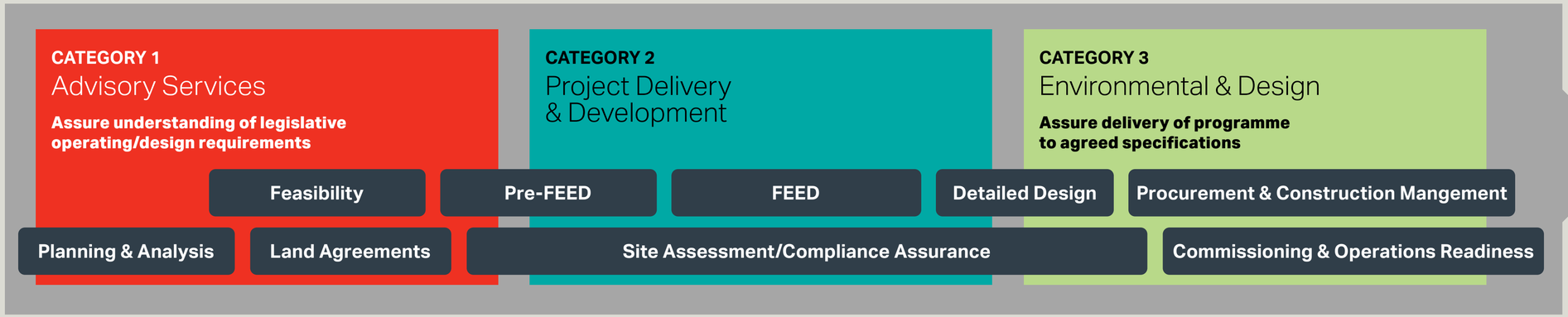
SUPPLIED MATERIALS/EQUIPMENT) Over the years, AECOM has developed a best-in-class process to support the selection and management of external subcontractors and suppliers when sourcing for direct services, equipment or materials on behalf of our clients.

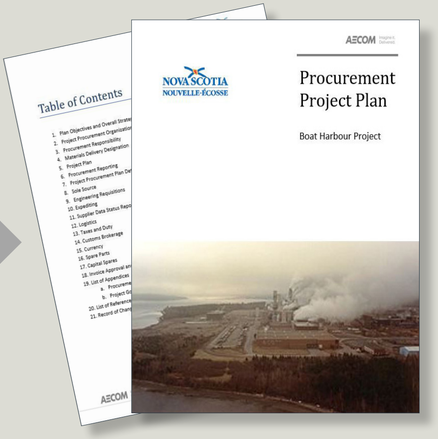
The strategic sourcing process optimizes value delivery through the sourcing process and supplier management. A well planned and executed strategic sourcing process can aid our clients in achieving their strategic objectives.

Key AECOM Attributes

- Improved delivery
- Increased standardization
- Reduced commercial risk
- Greater access to supplier's scale, scope, technology expertise, and resources
- Improved profit
- Increased collaboration
- Improved supplier performance
- Assured price reasonability
- Increased information sharing and efficiency gains
- Fewer relationships with more extensive long-term collaboration

AECOM Supports the Lifecycle of Project Development and Delivery of Hydrogen Mobility Projects





A sampling of our work

Project Experience

ADVISORY SERVICES

- Strategic options assessment
- Strategic roadmap development
- Existing infrastructure assessment/ grid connection
- Transitional and new infrastructure assessment
- Process safety assessments
- Regulations and technical standards assessments

PROJECT DEVELOPMENT AND DELIVERY

- Feasibility studies
- Engineering and design
- Owner’s engineer services
- Lender’s engineer services
- Integrated delivery (EPCM) services
- Construction management services (CM)

ENVIRONMENTAL CONSULTING

- Permitting
- Environmental Impact Assessment
- Health, Safety & Environment
- Resilience strategies/ Climate adaptation strategies

A sampling of our work

Project Experience

1. Assessment of Reviewing Hydrogen Production as a Complement to Offshore Wind

2. Mobility Program Delivery

3. Louisiana Low Carbon Fuels Carbon Capture and Storage

4. Owner's Engineer for 120 MWe Villeta Green Ammonia Project

5. Carbon Capture and Storage

6. Future of Hydrogen Industrial Conversion Feasibility Studies

7. Engineering and Design for Green Hydrogen Production Facility

8. Alternate Fuels Assessment

STR ATEGIC ADVISORY SERVICES

- Strategic options assessment
- Strategic roadmap development
- Existing infrastructure assessment / Grid connection
- Transitional and new infrastructure assessment
- Process safety assessments
- Regulations and technical standards assessments

PROJECT DE VELOPMENT AND DELIVERY

- Feasibility studies
- Engineering and design
- Owner's engineer services
- Lender's engineer services
- Integrated delivery (EPCM) services
- Construction management services (CM)

ENVIRONMENTAL CONSULTING

- Permitting
- Environmental Impact Assessment
- Health, Safety & Environment
- Resilience strategies / Climate adaptation strategies

1. Assessment of Reviewing Hydrogen Production as a Complement to Offshore Wind

AECOM's deep regulatory and energy experience is assisting BOEM in identifying permitting and regulatory changes needed to advance hydrogen as a complementary transport mechanism for offshore wind energy.

PROJECT OVERVIEW

The hydrogen molecule (H2) is an emerging energy vector that can be used as a clean-burning fuel and can be produced from both conventional and renewable energy sources. Green hydrogen produced from renewable energy creates an opportunity to transport, store, and use carbon-free energy in industrial, transportation and other sectors traditionally powered by liquid and gaseous hydrocarbon fuels.

Offshore wind (OSW) power on the Outer Continental Shelf (OCS) is a significant renewable resource that can support utility-scale green hydrogen production in the United States (US), with active development development and permitting underway. US federal policy supports continued expansion of OSW in support of the transition toward renewables and reduction of greenhouse gas (GHG) emissions while enhancing national energy security.

H2 production, storage, and distribution technologies are rapidly evolving, and regulatory frameworks for managing relevant aspects of H2 production from offshore wind energy (H2-OSW) will need to anticipate emerging H2-OSW implementations throughout US coastal waters. While hydrogen production technology has already evolved to a point where it can be sited complement to offshore wind projects, research and development to improve safety, efficiency, and commercial readiness of such coupling are still in early stages.

CLIENT
BOEM

LOCATION
US Outer Continental Shelf (OCS)

CONTRACT VALUE
USD 138K

YEARS
2021-present

2022 CCBJ BUSINESS ACHIEVEMENT AWARDS WINNER

Proud winner of the *2022 Climate Change Business Journal Award for Project Merit*:

Renewable Energy

CLIENT BENEFITS

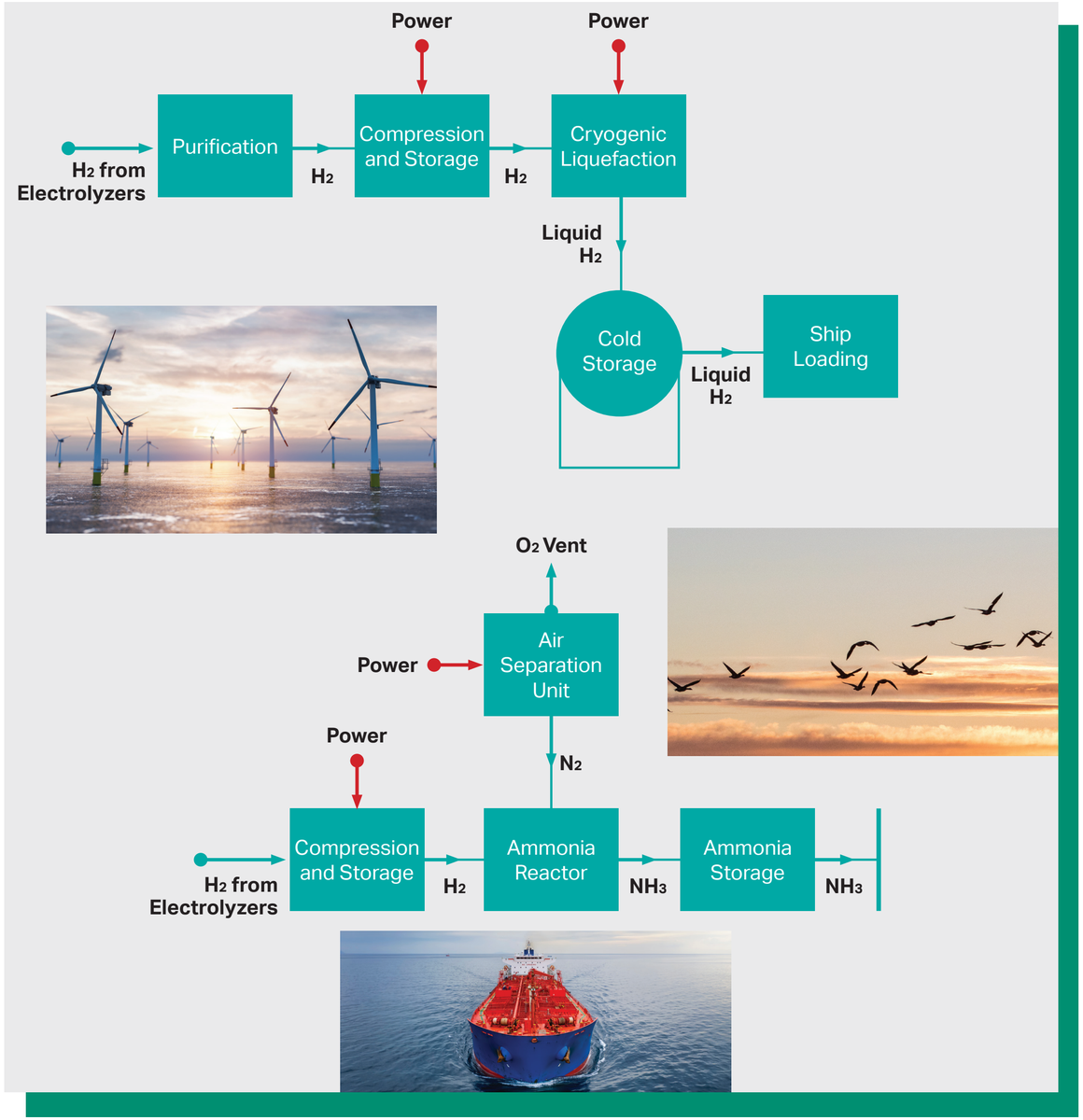
AECOM's experience provided the right fit and perspective to thoroughly engage this analysis of an emerging energy sector:

- Extensive offshore technical and permitting support
- Broad and diverse client base across energy sectors
- Longstanding support of BOEM and other federal agencies / familiarity with priorities and process
- Coordinated team approach synthesizing regulatory expertise with technical research and development capabilities for both offshore wind and hydrogen

WORK PERFORMED

AECOM's scope of work is to provide BOEM with the necessary background, analysis, and recommendations to update existing regulatory guidance for offshore development on the OCS, and to identify existing gaps in technical review expertise required for administering hydrogen production as a complement to offshore wind energy (H2-OSW) permitting and for safety enforcement under BSEE. The hydrogen molecule (H2) is an emerging energy vector that can be used as a clean burning fuel, which can be produced from OSW energy as a fully green fuel. A robust H2 energy sector is a United States (US) federal priority supporting national energy security and resilience, contributing to climate and environmental policy goals.

Developed through diversified research and interactive workshops, AECOM developed a report and peer-reviewed journal article to recommend updates to permitting and regulatory guidance, including amendments for existing leases, integrating H2-OSW in the existing OSW stakeholder engagement process and fully incorporating H2-OSW on the OCS as an option in future leases. We have also included recommendations for the environmental assessment requirements and provide suggestions to repurpose some of the existing regulatory frameworks including OCS oil and natural gas to address potential regulatory gaps. Our final report also includes recommendations for technology development, analyses of diverse business cases, and additional research avenues to promote adaptable development, reduce potential environmental impacts, and design mitigation measures.



2. Mobility Program Delivery

PROJECT OVERVIEW

AECOM has supported the client in the design, permitting, procurement, project, construction and facilities management of their global mobility portfolio for over six years. In our role as engineering delivery partner, we have led the conversion of their portfolio to adapt to the varying requirements of a full range of low and zero carbon fuels including liquified natural gas, biofuels, hydrogen and electric vehicle charging.

WORK PERFORMED

Our work extends to support clients across Europe, the Americas, Asia and Africa. We continue to lead both the development of engineering standards as well as value improvement initiatives to substantially reduce the cost of future fueling and expedite the delivery schedule while integrating safety requirements. In execution we have saved over $300M USD of installation cost and realising a return of investment of over 20% on deployed capital.

Across a portfolio of thousands of stations, we manage the diverse requirements of stakeholders including permitting authorities, retailers, landlords, utilities and operators to ensure uptime availability of a full range of fueling solutions adapting to the everchanging infrastructure requirements.

CLIENT	LOCATION	CONTRACT VALUE	YEARS
Supermajor Oil & Gas Client	Global	Confidential	2017-present

3. Louisiana Low Carbon Fuels Carbon Capture and Storage

AECOM's experienced permitting team and comprehensive technical capabilities helped the client navigate permitting needs for air quality, sensitive wetland habitats, significant cultural resources, and supported community engagement.

PROJECT OVERVIEW

AECOM was contracted to provide environmental review and support to include technical studies and permitting assistance for a proposed low carbon fuels carbon capture and storage project in Ascension Parish in southern Louisiana along the Mississippi River.

CLIENT BENEFITS

- AECOM provided a comprehensive permitting plan and managed development of critical permitting data needs to accelerate permitting.
- AECOM conducted cultural resource studies that included locating and preserving a mid-19th century cemetery.
- AECOM led the evaluation of alternatives to support USACE and Coastal Use Permit applications and demonstrate resource impact avoidance and minimization to keep the local community informed of plans and project progress.

WORK PERFORMED

The new facility includes hydrogen plants combined with CO_2 capture and storage. Agency coordination, included USACE, Ascension Parish, Louisiana DNR, Office of Coastal Management, and Maurepas Swamp Wildlife Management Area.

Provided assessment/permitting for including:

- Air emissions and air quality permitting
- Waters of the US assessment and wetlands delineation
- CO2 pipeline environmental studies and alternatives analysis
- Stratigraphic test well studies and permitting
- Federally threatened and endangered species habitat assessment
- Cultural resources assessment and field studies
- Coastal Use Permit application and agency coordination
- Compensatory mitigation planning
- Section 408 permitting
- Seismic study permitting for sequestration site
- Scenic rivers permit
- Louisiana NPDES permit
- Parish permit coordination
- Public trust doctrine analysis
- Environmental Justice analysis
- Facility intake sampling and analysis
- Pipeline route analysis and options

CLIENT	LOCATION	CONTRACT VALUE	YEARS
Air Products Blue Energy, LLC	Louisiana, USA	USD 3.7MM	2021-2023

4. Owner's Engineer for 120 MWe Villeta Green Ammonia Project

AECOM's work enabled ATOME to procure a Front End Engineering Design for a world-leading green ammonia project, enabling ATOME to become first-mover in the space and lead global development of this renewable fertilizer and transport fuel.

PROJECT OVERVIEW

Ammonia is an important chemical with many uses (fertilizer) and as a potential transport fuel of the future. It is produced on massive scales globally, and is one of the top-ranking chemicals manufactured in volume. Traditionally, ammonia has primarily been produced through steam reforming of natural gas into hydrogen and subsequent reaction with nitrogen separated from air in the Haber-Bosch process. This method produces notable quantities of greenhouse gas and contributes significantly to the environmental footprint of the agricultural industry globally.

A novel approach to ammonia manufacturing uses hydrogen generated through electrolysis of water using renewable electricity. This method eliminates the use of fossil fuel and carbon dioxide emissions with the resulting ammonia referred to as "green ammonia". The technology is limited at present due to the availability of excess renewable electricity and the cost of the produced ammonia being greater than that produced conventionally. This is expected to change as the world moves away from fossil fuels.

AECOM is working with the client to develop a 120 MWe green ammonia facility, drawing power which is 97% carbon free from an existing major hydropower facility in Paraguay to provide ammonia to meet local fertiliser demand. AECOM is acting as the Owner's Engineer, shaping the technical and contractual solution for this ambitious commercial project which will produce its first ammonia in late 2025.

- 120 MWe green ammonia facility will begin producing in 2025 to meet local fertilizer demand
- Production output of 88,000 tonnes per year

CLIENT BENEFITS

- The facility will offset circa 88,000 tonnes per annum of fossil-produced ammonia currently being imported into Paraguay for agriculture.
- Later project stages may allow for green hydrogen to be exported as a product as well as ammonia as a transport fuel, creating environmental benefits by providing a low carbon fuel and thermal energy source.
- Client preference to utilize local labour for construction of the plant will provide community benefit through the creation of jobs.

CLIENT	LOCATION	CONTRACT VALUE	YEARS
ATOME Energy PLC	Paraguay	130,000 GBP up to procurement of FEED	2022-present

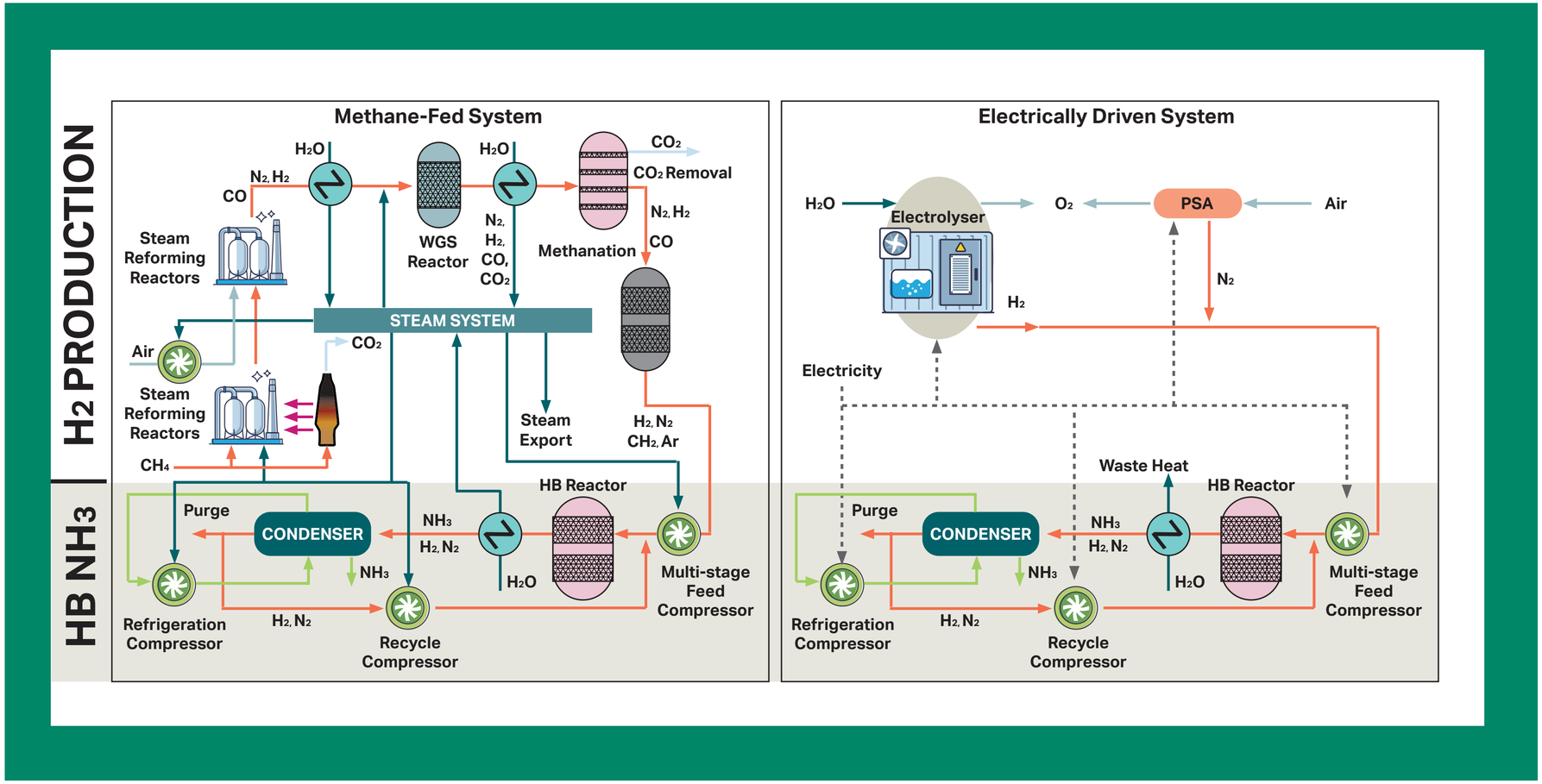
Proud winner of the *2022 Climate Change Business Journal Award for Project Merit:*

Green Hydrogen

- The existing relationships AECOM holds with electrolyzer vendors from previous projects presented a client benefit by accelerating engagement with suppliers.
- AECOM's ability to produce a technology agnostic preliminary design allowed for engagement with a wider variety of suppliers in later stages of the project may lead to a more suitable and cost-effective final design.
- Design decisions were continuously challenged by AECOM against the hierarchy for carbon reduction potential (Build Nothing, Build Less, Build Clever, Build Efficiently) to ensure that the plant's environmental impact is kept to an absolute minimum.
- AECOM's identification of plant areas suitable for pre-investment minimizing costs and simplifying expansion at later project stages.

WORK PERFORMED

AECOM developed a concept design for the facility and undertook pre-qualification of FEED contractors and technology suppliers, prepared a tender pack and distributed this to the shortlisted FEED suppliers, carried out tender evaluation and developed contract technical schedules and supported with all aspects of the procurement process.



5. Carbon Capture and Storage

Once completed this project aims to safely store CO2 from hydrogen production, prioritizing local environmental protection and minimizing greenhouse gas emissions.

PROJECT OVERVIEW

AECOM provided environmental review and supporting technical studies, and permitting assistance for a proposed carbon capture and storage project in the lower Delta and Suisun Bay areas of Contra Costa, Solano, and Sacramento counties. Project components evaluated included injection wells, carbon capture and liquefaction facilities, carbon storage facilities, and a combination of pipelines, marine terminals and barge transport options. AECOM worked closely with the client to develop and refine a proposed project permitting strategy and schedule. Additionally, AECOM's Ports and Harbors Group provided support to identify potential ports to accept, store and distribute green ammonia. This included siting studies of potential locations, infrastructure assessment with recommendations for necessary improvements and storage capabilities.

CLIENT BENEFITS

- Identified proposed project alternative that met the client's objectives and minimized environmental and permitting risks.
- Community outreach services that kept the local community informed of plans and project progress.

WORK PERFORMED

- Evaluated injection wells, carbon capture and liquefaction facilities, carbon storage facilities, and a combination of pipelines, marine terminals and barge transport options.
- Worked closely with client to develop/refine a proposed project permitting strategy and schedule.
- Focused surveys for wetlands, endangered species, and cultural resources were conducted at several locations including Sherman Island, the Suisun Marsh, and at other locations in northern Contra Costa and southern Solano County.
- Developed permit applications for geotechnical investigations and supporting documentation for submittal to regulatory agencies.
- Identified potential ports to accept, store and distribute green ammonia: siting studies of potential locations, infrastructure assessment with recommendations for necessary improvements and storage capabilities.
- Agency coordination included: DWR, USACE, State Lands Commission, Regional Water Quality Control Board, San Francisco Bay Conservation and Development Commission, and Delta Stewardship Council.

CLIENT	LOCATION	CONTRACT VALUE	YEARS
Confidential	California, US	USD 3MM	2020-2022

6. Future of Hydrogen Industrial Conversion Feasibility Studies

This study provides insights for industrial consumers preparing to switch to grid hydrogen as a cost-effective and safe alternative to natural gas for decarbonization.

PROJECT OVERVIEW

AECOM carried out a UK government-funded project to survey seven industrial sites seeking to switch from natural gas to hydrogen as a means of decarbonization. The aim of this project was to understand the barriers to implementation, evaluate impact on design safety cases and hazardous area zoning, develop a concept design and estimate the capital cost for the preferred solution for seven sites and report finding in a summary report for public dissemination.

CLIENT BENEFITS

This study:

- Helped the local site owners understand barriers to implementation for hydrogen conversion, impact on design, safety and hazardous area zoning, and develop estimated costs.
- Helped the government understand barriers to implementation for future hydrogen conversion, the current availability of hydrogen capable equipment and areas for policy and funding development.
- Helped in the development of safety guidance and appreciation of the potential impacts due to hydrogen switching.
- Helped develop case studies and a knowledge base which will be shared with the wider stakeholder community through publication.

WORK PERFORMED

AECOM was commissioned by the Department for Business, Energy and Industrial Strategy to deliver seven hydrogen conversion feasibility studies for industrial sites that had been selected by BEIS to provide an initial site-level perspective on what are likely to be the key issues, factors and impacts should the national grid be converted to hydrogen in the future.

The main deliverables were site-specific hydrogen feasibility studies for the industrial sites along with a brief case study identifying the most significant factors likely to affect safety, feasibility, cost and key factors in any decision of whether a site switches to hydrogen or not.

CLIENT	LOCATION	CONTRACT VALUE	YEARS
Department for Business, Energy & Industrial Strategy	United Kingdom	Confidential	2022

AECOM carried out the following activities:

PRE-SITE INSPECTION ACTIVITIES

Detailed requests for information were prepared along with inspection check lists to ensure that site visits were productive. Safe work plans were prepared ahead of the site visit and information provided was reviewed prior to the visits.

SITE INSPECTIONS

The site inspections included safety inductions, interviews with relevant staff members, site walkovers and review of information unavailable prior to site inspection.

TECHNICAL ASSESSMENT

The technical assessment considered the conversion feasibility and other viable alternatives, based on engineering considerations including understanding the existing energy use profile, availability of end use equipment and suitability of the existing infrastructure.

Techno-economic assessments were conducted to establish comparative emissions between decarbonization options, the associated CAPEX and OPEX and hence a levelized cost of carbon abatement comparison.

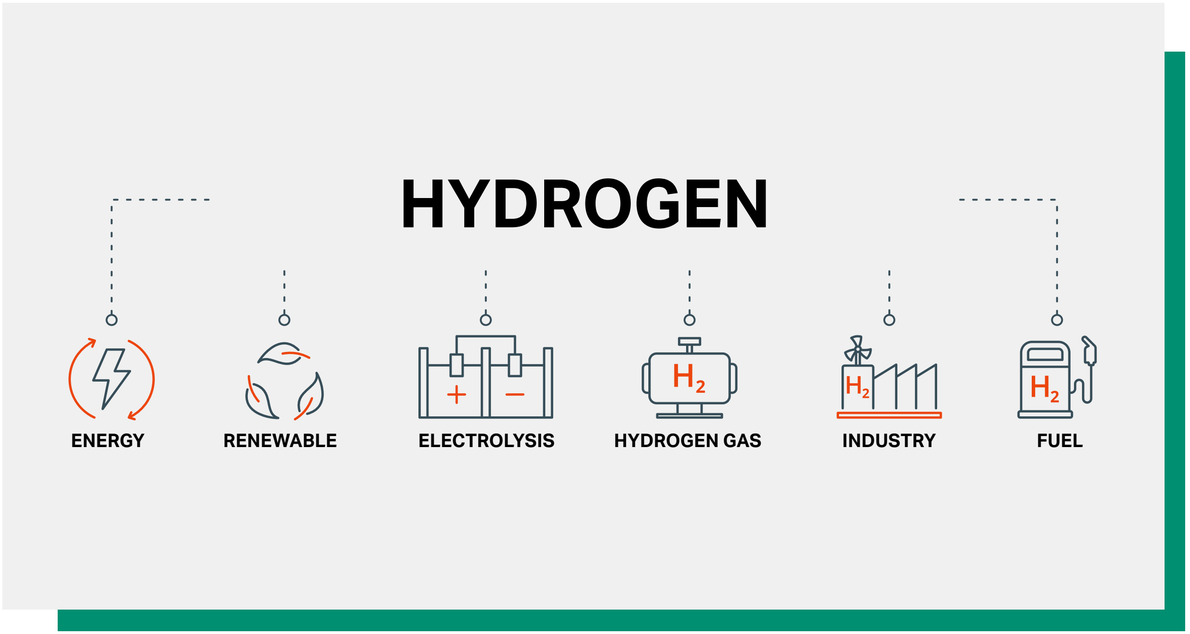
ENVIRONMENTAL ASSESSMENT

Alongside the technical assessment, the study considered the planning and environmental requirements to allow hydrogen conversion on an industrial site.

SAFETY ASSESSMENT

Safety assessments were carried out for each site to identify potential barriers both technical or economic. These included the following elements:

- HAZID including discussion of potential risks and mitigation
- DSEAR assessment to identify hazardous and non-hazardous areas
- Fire and explosion modelling to inform a high level consequence assessment



7. Engineering and Design for Green Hydrogen Production Facility

AECOM's design and engineering work on this project is advancing green hydrogen availability amid rapid demand due to its sustainability and versatility.

PROJECT OVERVIEW

Plug Power, a domestic leader in green hydrogen, has announced they plan to design and construct 500 TPD of green hydrogen production facilities in the US in the next 3-5 years. Project Gateway is one of the first units and it will be used as a template for future facilities. AECOM is serving as the engineer of record for the completion of the detailed engineering for this new facility.

ABOUT GREEN HYDROGEN

In the green hydrogen production process, electrolyzers break down deionized (DI) water from a combined reverse osmosis/DI water treatment process into hydrogen and oxygen. The bulk oxygen is vented and the wet hydrogen gas from the electrolyzer is de-oxygenated, cooled, and dried. Hydrogen gas is sent to the hydrogen liquefier units where it is pre-cooled with refrigerated nitrogen. The N2 re-liquefaction system is integrated within N2 refrigeration, N2 expander compressors, and pre-cooling perlite cold box system. The pre-cooled hydrogen undergoes ortho-para conversion to minimize boil-off in the liquid product. Hydrogen gas is liquefied using a hydrogen gas compression/expansion refrigeration loop. Hydrogen is also used as a refrigerant in a closed loop within the vacuum insulated cold box exchanger to achieve desired temperature for hydrogen liquefaction. Liquid hydrogen is moved to storage for transportation. Hydrogen flash gas is captured and recycled to minimize loss.

CLIENT BENEFITS

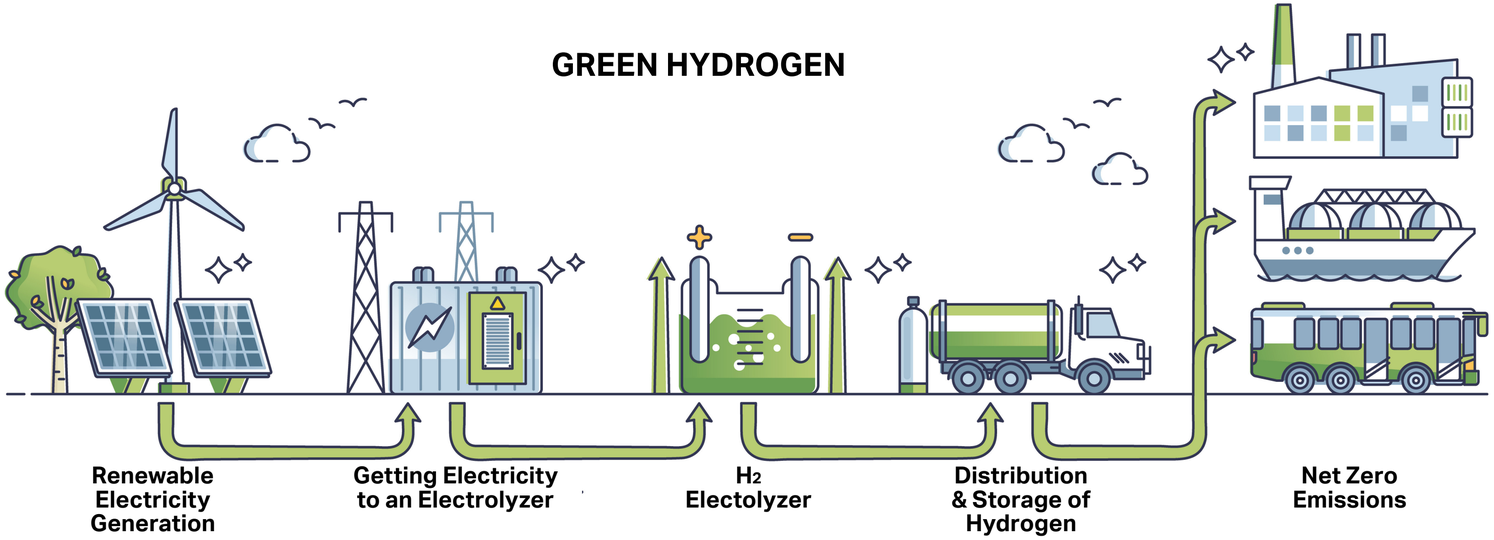
- 100% SUSTAINABLE | Green hydrogen does not emit polluting gases either during combustion or during production.
- STORABLE | Hydrogen is easy to store, which allows it to be used subsequently for other purposes and at times other than immediately after its production.
- VERSATILE | Green hydrogen can be transformed into electricity or synthetic gas and used for commercial, industrial or mobility purposes.
- DEMAND | The demand for domestic green hydrogen is forecasted to quickly outpace production capacity.

CLIENT	LOCATION	CONTRACT VALUE	YEARS
Plug Power	New York, US	Confidential	2022-present

WORK PERFORMED

AECOM is serving as the engineer of record for the completion of the detailed engineering for this new facility. Project Gateway will be a new, grassroots green hydrogen production facility in Alabama, New York. This new facility will include electrolysis, liquefaction, water treatment, storage/loadout, and all utilities for a 45 TPD facility. AECOM's scope includes design of the production trains comprised of mini substations, electrolyzer system, rectifiers, electrolyzer arrays, H2 deoxo-dryer unit, cryoabsorber unit, liquefaction system, and compressed N2 systems.

From this project, AECOM is getting firsthand design experience for commercial scale green hydrogen production from electrolysis. This project employs Plug Power-owned technologies (Frame electrolyzers and Joule liquefaction) which are being implemented in green hydrogen production facilities around the world. In the US, this is one of the first commercial applications to be installed.



8. Alternate Fuels Assessment

Sacramento Municipal Utility District (SMUD) aims to reach net zero carbon in its power system and operations by 2030 while ensuring reliability and affordability. Crucial to this goal is the decarbonization of its LM6000 thermal fleet.

PROJECT OVERVIEW

The client has set a bold goal to eliminate 100% of their greenhouse gas emissions from their electric generation by 2030. Their "Zero Carbon Plan" will reduce emissions, improve local air quality, overall resident health and create jobs. One arm of the plan involves investigation of new technologies and business models, including launching pilot projects and programs to test and prove new and emerging technologies and develop paths for prioritizing technology adoption and scaling.

The project will deliver a recommended approach to achieving net zero generation for SMUD's Carson and Proctor and Gamble generating units over the 2025 to 2045 period, including the potential to switch out the units.

CLIENT BENEFITS

- Retiring/refueling the client's gas power plants will help them reach their zero emissions goal.
- The client is targeting operating a portion of their plants using green hydrogen and biofuels such as renewable gas from landfills, biodiesel and other renewable sources as needed to operate for reliability.

WORK PERFORMED

AECOM and Energia conducted a feasibility study into decarbonization options for SMUD's fleet of aero derivative combined and open cycle gas turbines. The study involved assessment of a range of potential low carbon gaseous and liquid fuels, technical readiness of the prime movers and the supply chain capacity.

The study included a high-level cost assessment of power plant conversion and emissions treatment for hydrogen readiness and indicative costing of suitable sized biomethane production facilities.

AECOM is also providing environmental review and supporting technical studies, and permitting assistance.

CLIENT	LOCATION	CONTRACT VALUE	YEARS
Sacramento Municipal Utility District	California, US	USD 138K	2021-2022

About AECOM

AECOM is the world's trusted infrastructure consulting firm, delivering professional services throughout the project lifecycle – from advisory, planning, design and engineering to program and construction management. On projects spanning transportation, buildings, water, new energy, and the environment, our public- and private-sector clients trust us to solve their most complex challenges. Our teams are driven by a common purpose to deliver a better world through our unrivaled technical and digital expertise, a culture of equity, diversity and inclusion, and a commitment to environmental, social and governance priorities. AECOM is a Fortune 500 firm and its Professional Services business had revenue of US$14.4 billion in fiscal year 2023. See how we are delivering sustainable legacies for generations to come at aecom.com and @AECOM.