Jacobs Challenging today. Reinventing tomorrow.

Jacobs & Hydrogen

Our experience and capability in supporting the emerging hydrogen economy

Jacobs

Jacobs is a leading global professional services organisation, providing solutions for a more connected, sustainable world.

Challenging today.
Our unique approach to challenge what's accepted, using our expertise and knowledge to rethink the way we solve problems.

Reinventing tomorrow.
The outcome, from the innovations we build for our clients to the positive impact our solutions have on the world.

#1 Engineering Design Firm in the World
Engineering News-Record

FORTUNE WORLD'S MOST ADMIRED COMPANIES 2020

Ranked by **Fortune's 2020 World's Most Admired Companies** list in its sector, securing the No. 1 spot this year for the second year in a row.

Sustainable Hydrogen - Our Role
Jacobs plays a key role in exploring the unique synergistic relationship between the industrial and commercial sectors, renewables, hydrogen production and carbon captures, which further bolsters our climate action plan and in turn supports the commercial readiness of this emerging market.

Jacobs provides end-to-end solutions for clients' most complex projects using predictive analytics, artificial intelligence and automation, digital twin technology, IoT smart sensors, geospatial visualization and advanced delivery processes and tools for consulting, planning, architecture, design, engineering, and implementation, and long-term operation of facilities and infrastructure.

Jacobs Hydrogen Expertise

Strategy
Developing decarbonization strategies & planning for hydrogen infrastructure including Feasibility & Business Case Development, Concept Designs, and Simulation Systems Modelling

Nuclear
Hydrogen high temperature electrolysis. Fusion design and safety

Liquified Hydrogen
NASA specialist teams operate across NASA launch & test facilities

Speciality Chemicals & Hydrogenation
Specialist team of (de)hydrogenation SMEs with experience across industries regarding Liquid organic hydrogen carriers (LOHC) and green ammonia

Energy Storage
Integration of hydrogen fuel cells into power infrastructure, manufacturing and commercial facilities.

Materials Testing
Hydrogen materials testing laboratories
- UK nuclear laboratories
- NASA test facilities

Export / Import & Maritime
Design of facilities capable of handling liquified gases and LOHCs (e.g. Ammonia)

Energy Market Modelling
Specialist power modelling capabilities includes ability to accurately forecast prices, storage requirements and green hydrogen costs, supporting PPA agreements.

Full Project lifecycle Capability incl. Engineering Design and Program Delivery
Undertaking the engineering and delivery of hydrogen developments / plant design

Transportation
Integration and network planning, as well as energy systems design for:
- Buses
- Rail
- Aviation
- Green Fleet conversion

Safety & Risk
Detailed modeling and QRA capabilities relating to hazardous and explosive materials or substances

Gas Utilities
Integration of hydrogen into gas utilities and power networks

Water
Developed unique economic models for integration of hydrogen into wastewater treatment facilities, for energy and production efficiency

Power Generation and Networks
Engineering capabilities to support conversion of coal and gas plants to hydrogen and ammonia. Design of power networks integrating variable renewables/storage etc.

Selection of European Project Experience - Examples

MOBILITY, STRATEGY

Welsh Government
Advised the Welsh Government and several local authorities to develop opportunities and outline delivery plans to accelerate the uptake of zero emission vehicles.

H_2 MARKET STRATEGY
Welsh Government & North Wales Economic Ambition Board

Hydrogen Market Assessment and Distributed Energy Generation Innovation - (heating, power and transport) and innovative distributed power and heating technologies

H_2 MARKET STRATEGY

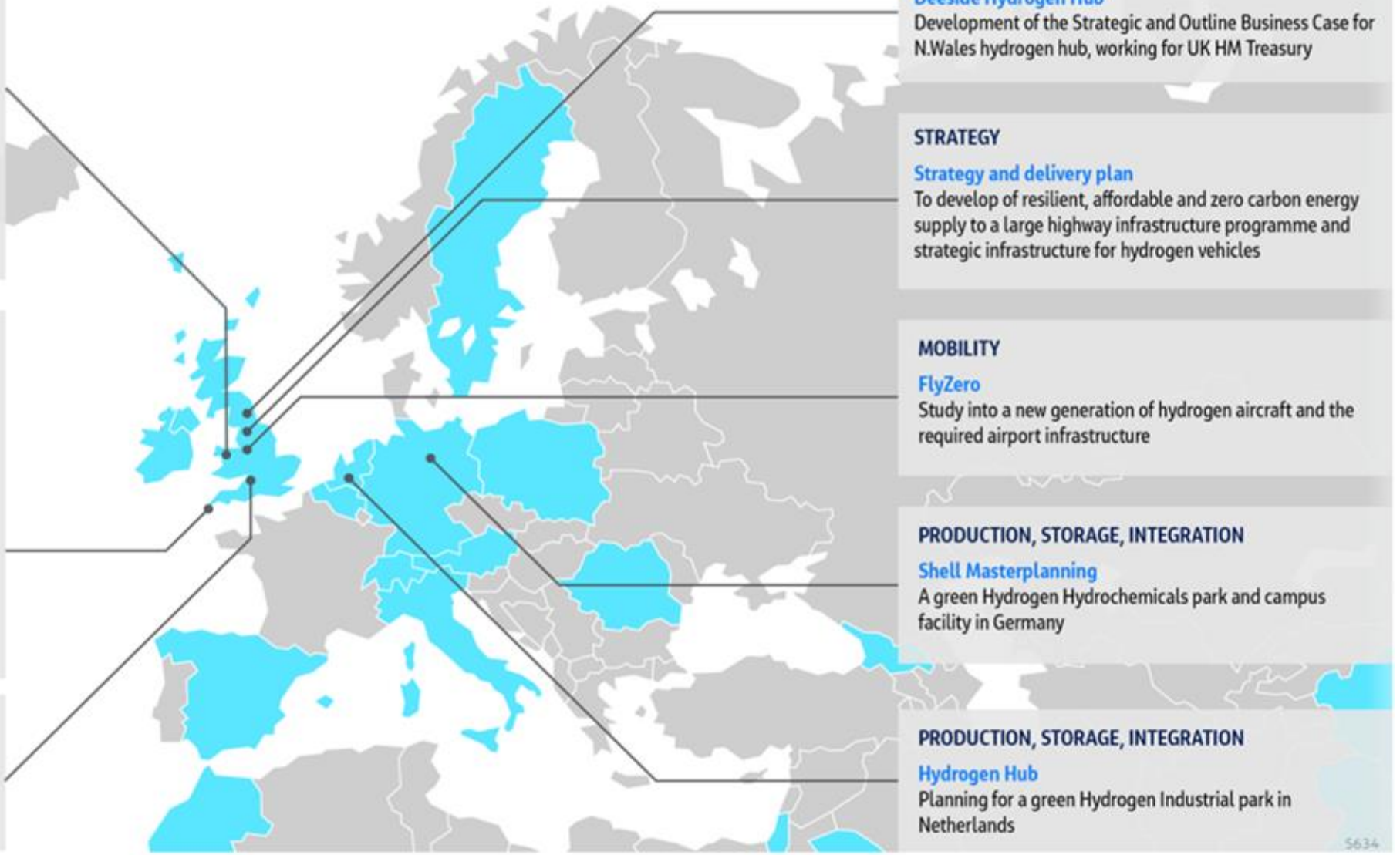
Energy Services 20 Year Business Strategy
Delivered an evaluation of market and policy drivers, capabilities and technology opportunities, including new flexibility and hydrogen markets for investment opportunities for distribution, transport and power generation

PRODUCTION, STORAGE

6MW renewable hydrogen plant
Provided preliminary engineering design, cost estimation and economic modelling for a 2.5 tonnes per day (6MW) renewable hydrogen plant

PRODUCTION, STORAGE

RWE Pembroke
Feasibility study into a 100MW green hydrogen plant to support industrial application and local transport demand



STRATEGY

Deeside Hydrogen Hub
Development of the Strategic and Outline Business Case for N.Wales hydrogen hub, working for UK HM Treasury

STRATEGY

Strategy and delivery plan
To develop of resilient, affordable and zero carbon energy supply to a large highway infrastructure programme and strategic infrastructure for hydrogen vehicles

MOBILITY

FlyZero
Study into a new generation of hydrogen aircraft and the required airport infrastructure

PRODUCTION, STORAGE, INTEGRATION

Shell Masterplanning
A green Hydrogen Hydrochemicals park and campus facility in Germany

PRODUCTION, STORAGE, INTEGRATION

Hydrogen Hub
Planning for a green Hydrogen Industrial park in Netherlands

5634

European Project Experience

Overview

- Feasibility study for a Phase 1 c.100MW Electrolyser Plant
- Potential to scale up to multi-GW deployment at the Pembroke site
- Forms part of the wider regional net zero initiative to maximise:
  - potential for hydrogen production
  - renewable generation and
  - CCUS
- Contribute to a sustainable growth model for Welsh hydrogen

Phase 1 - 110MW Total
To supply the industrial Offtaker with a portion for local transport

Phase 2 - >250MW Total
Demand primarily from the IO increasing supply on Phase 1

Phase 3 - >600MW Total
Expansion to fully meet IO demand with expansion into other markets

Phase 4+ - Multi-GW
Long term development of the site & integration into the SWIC

Project Definition

- **Global hydrogen team**
  - a multi-faceted approach & covered the full project envelope
- **Local knowledge and experience**
  - planning/permitting and constraints
- **Collaborative working with RWE**
  - identify and evaluate key constraints, assumptions and requirements
- **Optioneering analysis** and recommendations
  - potential solutions
  - implications on **funding**
- **Market analysis** on electrolyser, costs, control philosophies
- Output was an **outline design specification** with supporting business case, project schedule and risk register

RWE Pembroke Net Zero Centre (PNZC)

South Wales Industrial Cluster (SWIC)

RWE

European Project Experience

Overview

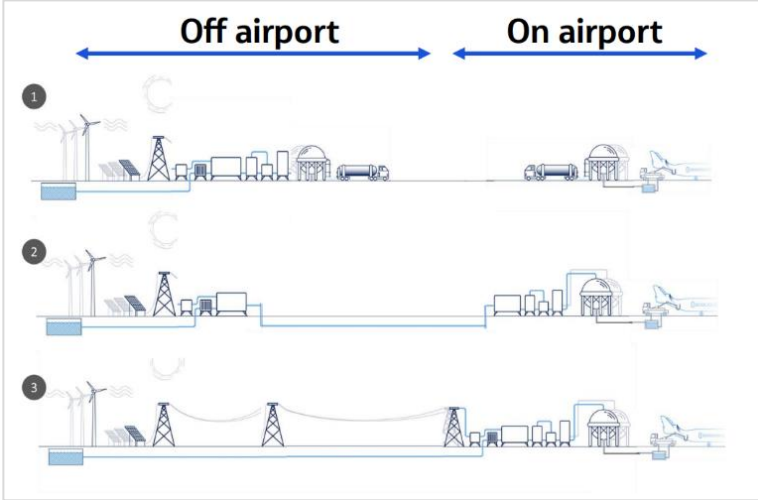
- FlyZero, U.K. study into zero-carbon emission commercial air travel, in its vision for a new generation of aircraft powered by hydrogen
- Specialist aviation and hydrogen expertise into the report, "**Airports, Airlines and Airspace - Operations and Hydrogen Infrastructure**"
- Five U.K. airports to define the hydrogen infrastructure needed to support the operation of hydrogen powered aircraft.

Project Definition

- Three scenarios were investigated for the application of on-airport hydrogen infrastructure:
  1. on site production of hydrogen through electrolysis and liquefaction
  2. off-site production of hydrogen gas transported to the airport via a pipeline where it is liquified
  3. off-site production of hydrogen with delivery by tube trailer trucks.

Key Work Packages

- Data and model preparation
- Simulation modelling
- Technologies assessment
- Airport masterplan preparation
- Hydrogen infrastructure assessment
- Airport stakeholder assessment
- Sustainability assessment
- Challenges and Risk assessment
- Business case modelling



https://www.jacobs.com/newsroom/news/report-zero-carbon-flights-could-enter-service-2035

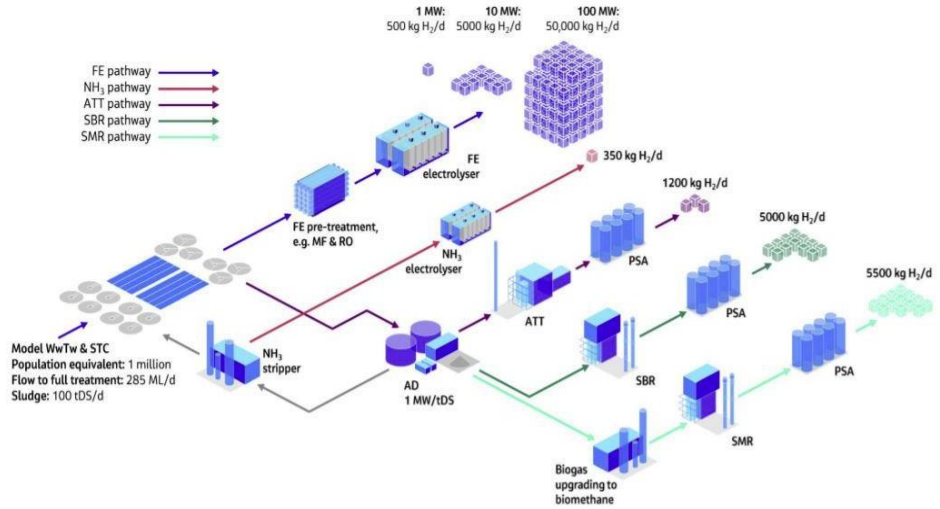
European Project Experience

Overview

- Working closely with a number of global water companies Jacobs is challenging the design to consider greater efficiencies and revenue streams through hydrogen production and use. This has incorporated technology innovation and business model opportunities. Building on this we have developed a series of thought papers:

Hydrogen Thought Leadership

- Aims to unpick some of the complexity, to manage some of the uncertainty around hydrogen and even provide a nucleus around which firm hydrogen strategies can be devised.
- Two detailed report and a series of papers 'The Water Sector and Hydrogen'
- A series of six discrete pathways examining the individual hydrogen production pathways in finer detail and exploring the engagement of the water sector with an emerging hydrogen economy, using the U.K. as a case study.



1. An Overview of the Series 2. The FE Pathway 3. The NH_3 Pathway 4. The ATT Pathway

Hydrogen Reports

[Australia's pursuit of a large scale hydrogen economy, 2019]

Can hydrogen live up to its potential for economic growth without compromising broader sustainability goals, including emissions reduction and water security?

[Towards a zero carbon future, 2020]

Explores the pivotal role of water utilities in defining a cost-effective and environmentally-friendly role for recycled water in hydrogen production

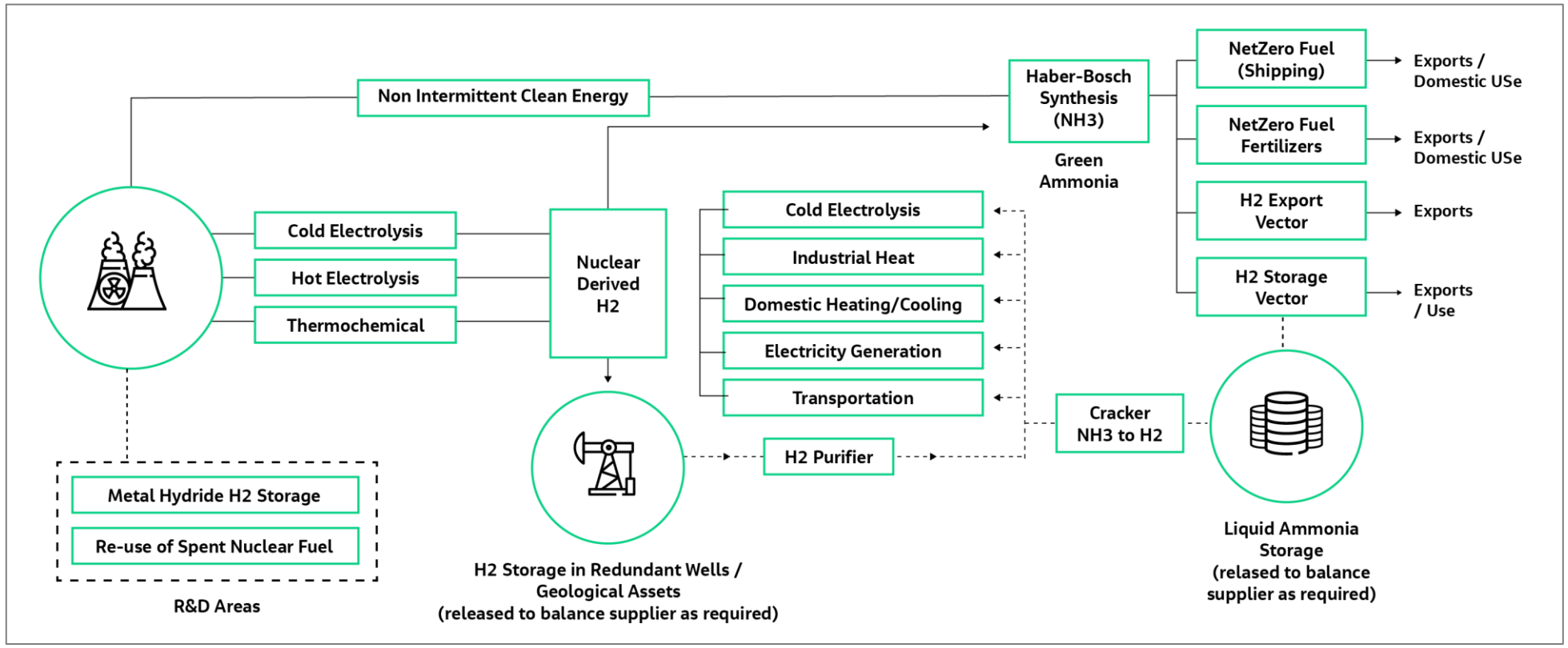
The Opportunity for Nuclear Diversification: Pink Hydrogen

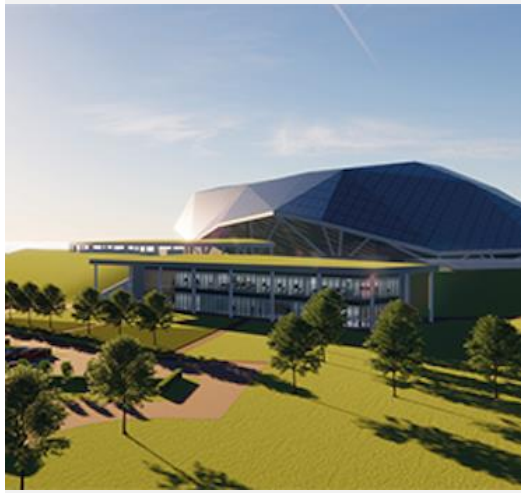
Jacobs Market Leadership Potential

Jacobs has an excellent relationship with existing OEMs, and is well positioned to work with partners across the value chain as a nascent market develops for this technology. With expertise and experience in both hydrogen and nuclear markets, we have the unique capability to deliver comprehensive solutions in pink hydrogen.

Case Study – Birchwood R&D Labs

- Jacobs is pioneering new nuclear technologies at the state of the art Birchwood (UK) R&D laboratories
- Supporting Moltex Energy in their development of a Stable Salt Reactor
- Jacobs are building a bespoke experimental facility for thermal transfer testing at its Birchwood Park research and development facility in the U.K.





Jacobs Nuclear Expertise

- Nuclear New Build
- Operational Support
- Decommissioning & Remediation
- Research Analytics & Technology

Jacobs & Hydrogen

Stephen Horrax
Carbon & Energy Consulting Director
Stephen.Horrax@jacobs.com

Stephen is the Head of Carbon and Energy Consulting and has 20 years of experience in program and project management, and has worked on policy, investment development and strategic projects for UK Government, private sector, academia and commercial consulting. Stephen has extensive knowledge of energy, carbon and resource management.

He manages the delivery of projects for alternative energy generation, energy and transport systems and low carbon strategy development to net zero, including the development of new technology opportunities. This includes business case development, implementation global award-winning green gas project delivery, programming and due diligence of proposed developments and operational change.

Thank you

Jacobs

Challenging today.
Reinventing tomorrow.

Jacobs Challenging today. Reinventing tomorrow.

Additional Information

Detailed Capability Statement

Jacobs & Hydrogen

Green Hydrogen Plant Design

Jacobs have developed key supply chain relationships / partnerships with a vast range of technology suppliers and OEMs. This allows Jacobs to provide a bespoke engineered solution, optimised to the individual requirements of each project we undertake.

- Electrolyser / technology Best Available Technique (BAT) analysis (PEM, AEM, Alkaline, SOEC).
- Electrolyser plant design.
- Balance of plant options and integration.
- Hydrogen storage solutions.
- Hydrogen transmission / export.
- Economic modelling for hydrogen production, storage and transportation.
- Regulatory, environmental and licensing constraints.

ITM POWER Energy Storage | Clean Fuel · SIEMENS energy · Hydrogen pro · PLUG POWER · Enapter · BOC · sunfire · Cummins · CPH2 CLEAN POWER HYDROGEN · Air Liquide · AIR PRODUCTS

Jacobs & Hydrogen

Market & Stakeholder Engagement

In the UK, the Jacobs Hydrogen Business Unit maintain a strong focus on market research, stakeholder engagement and policy analysis with both government and industry.

Policy Focus:

- August 2021 UK Hydrogen Strategy
- Hydrogen Production Strategy 2022
- Clean Maritime 2050 Plan
- Mission Innovation, Challenge 8
- Clean Marine Strategy
- BEIS Frontier Economics
- Hydrogen Business Models Study
- IMO Initial Strategy
- Industrial Fuel Switching Strategy
- CCC Net Zero 2050 Plan
- N11 Clean Growth Strategy

Stakeholder Engagement :

- BEIS Hydrogen Team
- BEIS Nuclear Team
- Hydrogen All Party Parliamentary Group (APPG)
- Nuclear All Party Parliamentary Group (APPG)
- Department for International Trade
- Northwest Hydrogen Alliance
- NNA - Nuclear-Hydrogen Committee
- KTN – Hydrogen and Nuclear SME Teams
- STFC – Hydrogen and Nuclear SME Teams
- University of Chester: Thornton Science Park
- Highlands & Islands University
- Teesside University

Department for Business, Energy & Industrial Strategy

appg All Party Parliamentary Group on Hydrogen

appg All Party Parliamentary Group on Nuclear Energy

NORTHERN NUCLEAR ALLIANCE

North West Hydrogen Alliance

University of Chester

Thornton Science Park

UKRI Science and Technology Facilities Council

ktn

Jacobs & Hydrogen

Skills & Experience for a New Market

Jacobs recognise that the hydrogen industry is evolving quickly and the need to provide surety in the advice and consultation, particularly in the initial design and permitting phase of project delivery is of key importance.

Jacobs specialise in:

- Planning, Permitting and Environmental Impact Assessment
- DESAR, COMAH, ATEX Hazardous Area Zoning Assessment
- Gas handling, storage, liquification and regulatory compliance.
- Process plant design and balance of plant integration
- Gas storage solutions: scale, energy efficiency, durability
- Integration of key plant equipment items to minimize CAPEX/OPEX
- Pipelines and infrastructure: flowrate, cost/km, H2 compressor etc
- Energy consumption and cost estimates across the supply chain
- Transport and loading: scale, footprint, efficiency, integration, safety
- Construction management and delivery
- Health and Safety Management
- Maintenance and asset management

Our Industry Experience:

Nuclear Industry | Petrochemical Industry | Power Industry | Water Industry | Maritime Industry | Aviation Industry | National Infrastructure

Jacobs & Hydrogen

Feasibility & Concept Design

Jacobs is a leading provider of feasibility, concept design and early hydrogen hub/cluster development. We help both government and industry understand how hydrogen can fit into their decarbonization strategies, including:

- Hydrogen hub / cluster development and master planning
- Economic modelling and business / financial investment case
- Best Available Technique (BAT) analysis (Hydrogen plant design)
- Concept design, specification development and high-level cost analysis
- Production site location identification and review
- End-user / hydrogen off-taker identification and analysis (linking with Jacobs: Marine, Transport, Defence, Power, Aviation, Water & Smart Cities divisions)

Our Experience:

RWE Pembrooke Net Zero Cluster (UK) | North Coast Hydrogen Cluster (UK) | Metrolynx Hydrail (Canada) | AHC Green Hydrogen (Australia) | H2 Production at Deep Water Port (Australia) | FlyZero Aviation Feasibility | Woodside Green H2 Plant

Jacobs & Hydrogen

Planning, Permitting Applications & Impact Assessments

Jacobs have significant experience in managing planning applications and permitting in complex, highly regulated industries such as defence, gas, water and nuclear. We take ownership of planning and permitting for our clients, including:

We Consider (typical)

- Construction Management Plan
- Locations of plant and anticipated footprint
- Utility & potential pipework connections
- Quantities of hydrogen to be stored
- Safety features of the plant
- Potential emissions to air and water
- Potential sources of noise emissions
- Sensitivity of the surrounding environment
- Proximity and location of sensitive receptors

We Deliver (typical)

- Land Use Planning
- Construction Management Plan
- Traffic Management Plan
- Environmental Management Plan
- Waste Management Plan
- COMAH Status and ATEX Management
- Fire Risk Studies
- Grid / utility connection requests
- Noise analysis and mitigation

Our Experience:

RWE Pembrooke Net Zero H2 Cluster | Hinkley Point C | Ministry of Defence (multiple sites) | HS2 Phase 1 | Sabic Orate H2 Plant Conversion

Jacobs & Hydrogen

Detailed Design & Tier 1 Project & Construction Management

Jacobs is a world leader for major program delivery, working across all disciplines of the delivery process for major infrastructure projects.
Jacobs offer:

- Early Contract Engagement (Post feasibility study) to reduce risk and jointly develop scope
- Feed studies and collaborative option-eering (reduce risk, costs and improve delivery)
- Detailed design and technical oversight (ownership of engineering and technical design)
- Tier 1 project management and program delivery
- Construction management and management of tier 2 contractors (CDMC principal contractor)
- Health and safety oversight and management
- Environmental and regulatory compliance oversight and management

Tier 1 Principal Contractor Experience:
ITER (worlds largest nuclear fusion project) | Hinkley Point C | Sizewell C | Thames Barrier | Palace of Westminster | MOD | HS2 | NASA KSC

Jacobs & Hydrogen

Full Project lifecycle delivery capability

Jacobs is a highly experienced provider of Full Project lifecycle capability services worldwide.

- Ownership of engineering, design and procurement on behalf of clients
- Delivery of turn-key solutions and integration of technologies (balance of plant)
- Project management and program delivery + management of supply chain
- Construction management and management of tier 2 contractors (CDMC)
- Health and safety oversight and management
- Environmental and regulatory compliance oversight and management
- Post project delivery support

Our Experience:
Sellafield BEP | Hinkley Point C | Sizewell C | ITER Fusion | Metrolinx Hydrail | Shell Bacton Gas Terminal | Esso Fuel Terminals

Jacobs & Hydrogen

Jacobs ‘end to end capability’ delivery for Scope & Balance of Plant

Electrolyser Partner Scope (Typical)

Electrolyser Technology	Transformer	Rectifier
Electrical Stack Connection	System Cabling	System Piping
Hydrogen & Oxygen Vent	Demin Water Distribution	Cooling System

Jacobs Project delivery scope

Utility Supply	Uninterruptable Power Supply	Switchgear Equipment
Demin Water Treatment Plant	Cooling Water Circuit	Control Room
Hydrogen & Oxygen Compression	Hydrogen & Oxygen Buffer	Hydrogen Storage & Transmission
Hydrogen & Oxygen Purifiers	Nitrogen & Instrument Air	Plant Safety Systems & Monitoring
Permitting & Licensing	Civil Works & Plant Building	Installation & Commissioning
Plant Pipework, design & Installation	Installation & Commissioning	Decommissioning & Site Remediation

Our Experience:

Sellafield BEP | Hinkley Point C | Sizewell C | ITER Fusion | Metrolinx Hydrail | Shell Bacton Gas Terminal | Esso Fuel Terminals

Jacobs & Hydrogen

Full Project lifecycle Delivery Capability

Jacobs Field Services (JFS) project management capability extends to over 160 Project Managers in the UK. Our approach to Project Management fosters an environment for agile working and innovative thinking.

Construction Management
Management and co-ordination of construction activities and operations as part of design and build projects or direct construction management activities on behalf of our clients.

Installation & Commissioning
JFS have over 500 trained craft personnel with core capabilities in mechanical, electrical, civils, instrumentation and HVAC installation, including fully accredited QC welding capability.

Operation & Maintenance
Our trained personnel are experienced in bespoke equipment and facility maintenance, including active monitoring maintenance. JFS offer full facility and integrated asset management.

Our Clients:
Sellafield | Shell Bacton Gas Terminal | Esso Fuel Terminals | BAE Systems | EDF | Magnox | Novartis Pharma | Scottish Power Renewables

Jacobs Challenging today. Reinventing tomorrow.

Specialist Capability & Experience

Jacobs & Hydrogen

Nuclear Derived Hydrogen

Nuclear Derived Hydrogen

- Next generation of nuclear reactors, known as Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs) offer co-generation opportunities, with hydrogen production seen as a key application.

- Can operate off-peak to produce H2 during low grid capacity or make use of high temperature waste heat/steam to make low cost 'pink' hydrogen using 'hot electrolysis' with SOEC type electrolysers.

We Offer

- Landscape / feasibility studies for SMR/AMR deployment into hydrogen hubs.
- Techno-commercial analysis of nuclear derived H2 production and levelised cost.
- Licensing, Citing and Consent for Co-Generation Nuclear + Hydrogen plants.
- Design and Project Delivery of Co-Generation Nuclear + Hydrogen plants.
- Asset management and operational assistance.

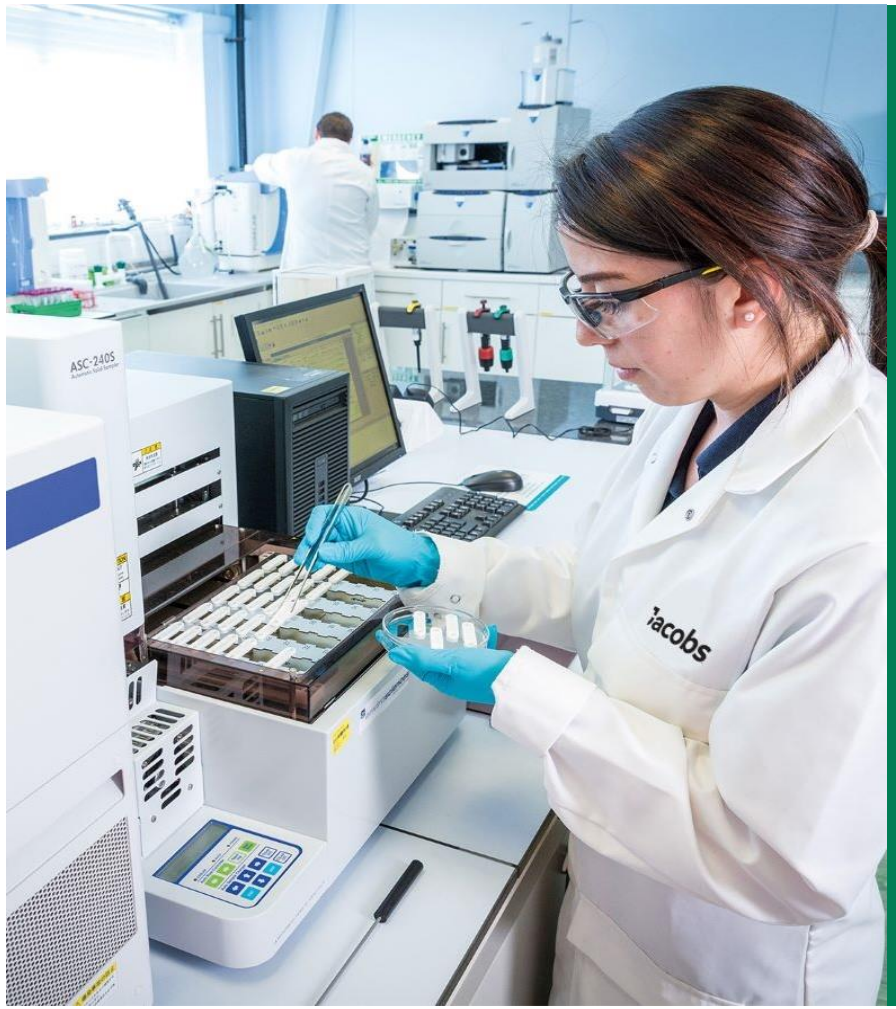
	PINK HYDROGEN A	PINK HYDROGEN B	PINK HYDROGEN C
Process	Electrolysis (PEM, Alkaline, SOEC, Cryogenic)	Hot-Electrolysis Thermally Enhanced (SOEC)	Thermo-chemical Water Splitting
Source	NetZero Power (off-peak H2 production)	SMR/AMR Uses waste Heat / Steam 500-700 Dec C	AMR (VHT) Uses waste Heat / Steam +1100 Dec C

Nuclear Derived Hydrogen

SMRs and AMRs are ultra compact, ranging from 2MW to 250MW. The smallest versions can be installed in modular shipping containers.

Jacobs & Hydrogen

Laboratory Services



Jacobs is developing a new hydrogen facility to add to its extensive laboratory campus at Birchwood.

From the new H2 laboratory, we will facilitate:

- New hydrogen production technology development
- Scale-up of novel electrolysers
- Qualification for the hydrogen value chain
- Materials & components characterization
- High temperature test capability

Across the rest of Birchwood, our portfolio include:

- 12,000m^2 of labs, test rigs and workshops
- More than 700 technical experts and practitioners
- World class expertise in gas, corrosion and materials

Jacobs & Hydrogen

Safety Case & Regulatory Development

From our position as the market leader for risk assessment and mitigation, regulatory research and development and safety case modeling in the nuclear industry, Jacobs have invested in additional capacity, skills and subject matter specialists to support the development of the global hydrogen economy.

We specialize in:

- Conducting full safety assessments of products and systems
- Product and component testing (e.g. artificial aging of PEM membranes)
- Structural, C&I, thermal, external/internal hazard assessments
- Legislation review and writing of industry guidance documentation
- Analysis and mitigation of legislative gaps
- Support activities for regulators (assessment of documentation, audits/inspections)

Jacobs & Hydrogen

Nuclear Derived Hydrogen

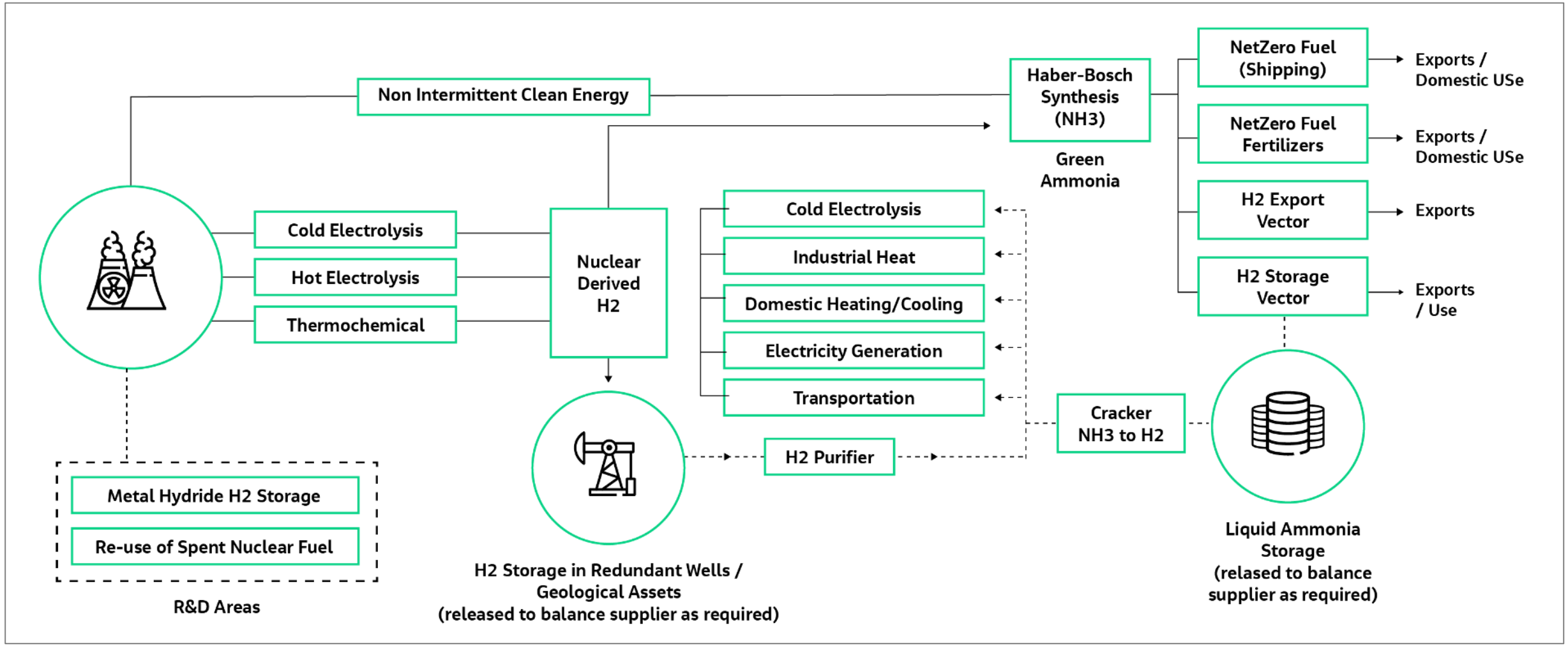
Jacobs are a global leader in all aspects of nuclear power, taking tier 1 project delivery positions on major projects such as Sizewell C, Hinkley Point and the ITER Fusion project. Together with our partnership with INL, Jacobs are strategically positioned to lead in the area of Nuclear derived hydrogen production.

Jacobs offer specialist experience & knowledge in:

- Landscape / feasibility studies (SMR deployment into hydrogen hubs / clusters)
- High Temperature Gas Reactor (HTGR), techno-commercial analysis (use in H2 production)
- Advise and consult on nuclear interface for optimum waste heat / steam delivery
- Advise and consult on SMR/AMR reactor design (optimise output for H2 production)
- Design and integration of SOEC and nuclear for enhanced hot electrolysis H2 production
- Advise and research thermochemical water splitting solutions
- Advise and consult on Energy Transition Policy e.g. BEIS HTGR Demonstrator Strategy

Jacobs & Hydrogen

Nuclear Derived Hydrogen (The Case for Nuclear)



Jacobs & Hydrogen

Hydrogen & Transfer Storage Solutions

Jacobs has +20 years experience in hydrogen storage, transmission, associated infrastructure design and related safety systems, through our extensive work with the NASA space programme. We take full ownership of the engineering, design & delivery.

Significant Key Experience Includes:

- Cryogenic storage and transfer system + vacuum jacketed piping (cryogenic) design
- High pressure storage and transfer systems
- Metal Hydride
- Flare stack design, safety case, permitting, storage & handling
- Hydrogen storage, permitting and planning applications
- Safety case, monitoring solutions & mitigation strategies
- Fuel cell interface & transfer
- Material assessment and compatibility studies (using Jacobs H2 Laboratories)

Jacobs & Hydrogen

Hydrogen Energy Carriers

Our culture fosters innovation and strives to challenge the accepted, through the delivery of world leading research and engineering development programs. Due to the future importance of Energy Carriers and alternative storage vectors to the energy transition challenge, Jacobs is conducting focused research in the following areas:

- Production of syntenic net zero Methanol
- Production of Synthetic Aviation Fuels (synfuel / syngas)
- Production of syntenic Ammonia using Green H2 and net zero Haber Bosh technologies
- Direct Ammonia generation using novel, high heat and high-pressure technologies.
- Alternative Haber Bosh catalysts for improved efficacy and interface with intermittent renewable power sources.
- Use of Oxygen byproducts e.g. medical use or wastewater treatment
- Key Policy Areas: IMO Initial Strategy, Maritime 2050 Strategy, Clean Marine Strategy

Jacobs & Hydrogen

Systems Engineering & Retrofit / Upgrade Programs

Jacobs has vast experience in Systems Engineering & technology integration. We lead the feasibility assessment, engineering and design / re-design of light to heavy commercial and specialist vehicles, to Hybrid Electric, EV and Hydrogen, as part of the global energy transition / industrial fuel switching mission.

- Active in defence, public transport, heavy industry & long-distance transport areas.
- Provide early 'art-of-the-possible' design engineering studies for fuel switching strategies
- Full systems V model capabilities, for feasibility, design, engineering, sustainability, testing and commissioning of vehicle design / redesign and disposal
- Expertise in Model Based Systems Engineering and through-life supportability management

Our Experience:
MOD TD6 Programme | Transport for Scotland | Dundee Bus H2 Fuel Cell Conversion | MOD Battlefield Electrification Strategy

Jacobs Challenging today. Reinventing tomorrow.

Global Project Experience

Selection of Global Project Experience – US Examples

POWER

Data Center backup Power
Design of a fuel cell system to replace a diesel generator for backup power in a data center

MOBILITY

Caltrans
Conversion of fleet of intercity diesel locomotives to HFC

San Bernardino County Transit Authority
Jacobs is the Owner's Engineer for the production of an HFC EMU by Stadler H_2 Sustainable Winery and Vineyard

MICROGRID STORAGE

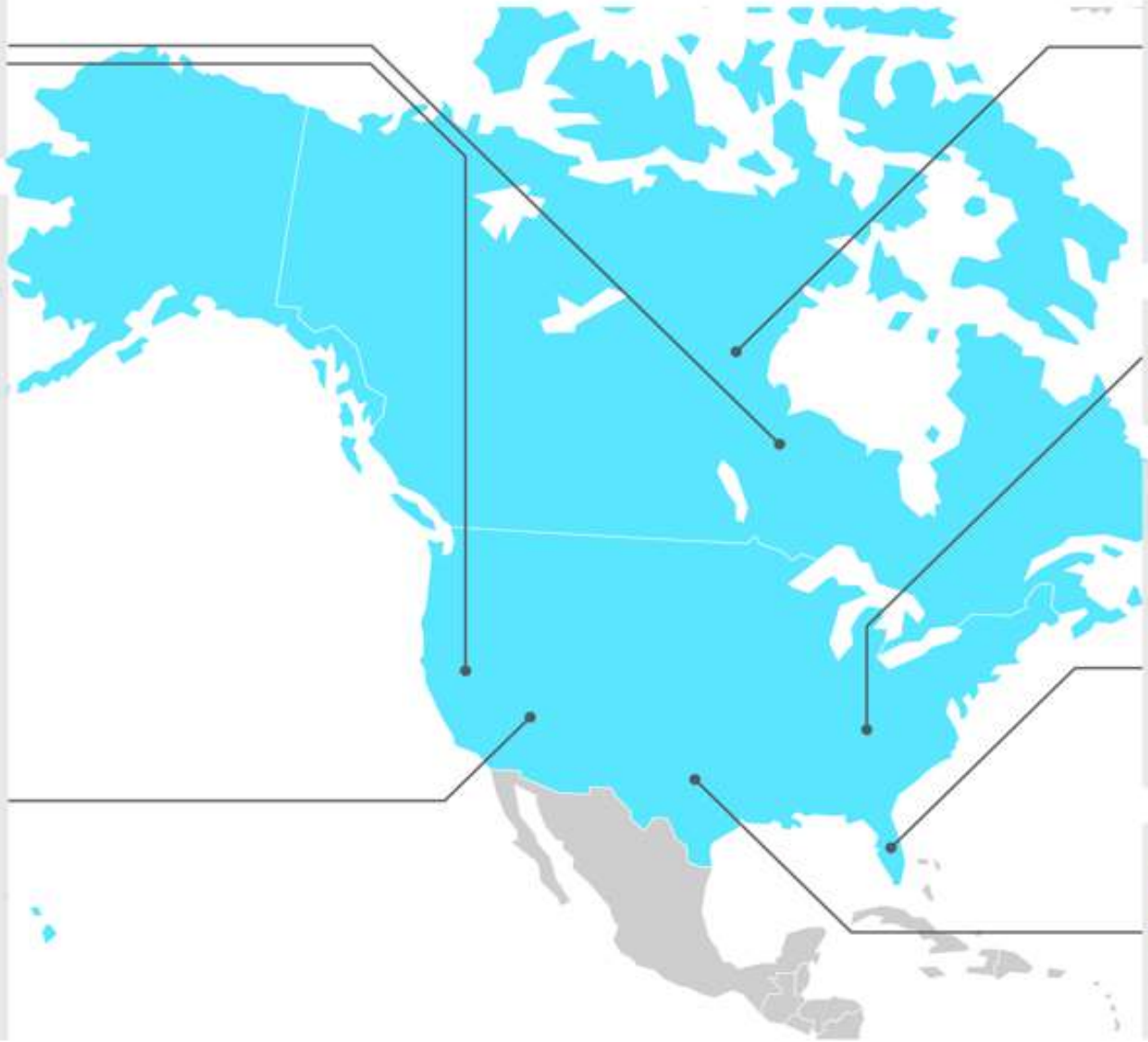
H_2 Sustainable Winery and Vineyard
Incorporating the production and use of hydrogen to create a 100% renewable energy microgrid

MOBILITY

Renewable Hydrogen Refueling Facility
Undertook feasibility studies plus designed a hydrogen bus hub for AC Transit in California.

PRODUCTION, STORAGE, POWER

Green Hydrogen production and Storage and power Investment Advisory
Technical, commercial, market and environmental due diligence for an investment consortium looking to invest in a large scale electrolyser facility, large volume H2 storage, and H_2 to power via CCGT, West Coast USA



STORAGE

Canadian Nuclear Laboratories
Jacobs is lead partner for $90M of hydrogen facilities supporting the development of hydrogen related expertise, products, and services, which support the deployment of a vast number of hydrogen end-uses

MOBILITY

Metrolinx Hydrail
H_2 rail feasibility study

MOBILITY

Massachusetts Bay Transit Authority
Preparation of design guidelines for the design of maintenance and refueling facilities for HFC buses

NASA
Support to NASA across all but one of their operations centers covering storage, handling and refueling of rockets using liquified Hydrogen, plus advising on safety and materials.

PRODUCTION, STORAGE, POWER

Green Hydrogen Production and Storage Feasibility and Cost Estimate
Feasibility and cost estimate for a utility company for a large scale electrolyser facility, large volume H_2 storage, and H_2 to power via CCGT, Southern USA

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Selection of Global Project Experience – APAC Examples

MANUFACTURING
Global Apparel Company
Developed conceptual designs for a manufacturing facility to meet aggressive global sustainability targets around carbon and energy use. Multiple concepts were evaluated including 'green' hydrogen (solar PV to generate hydrogen via electrolysis), biomass, and natural gas boilers.

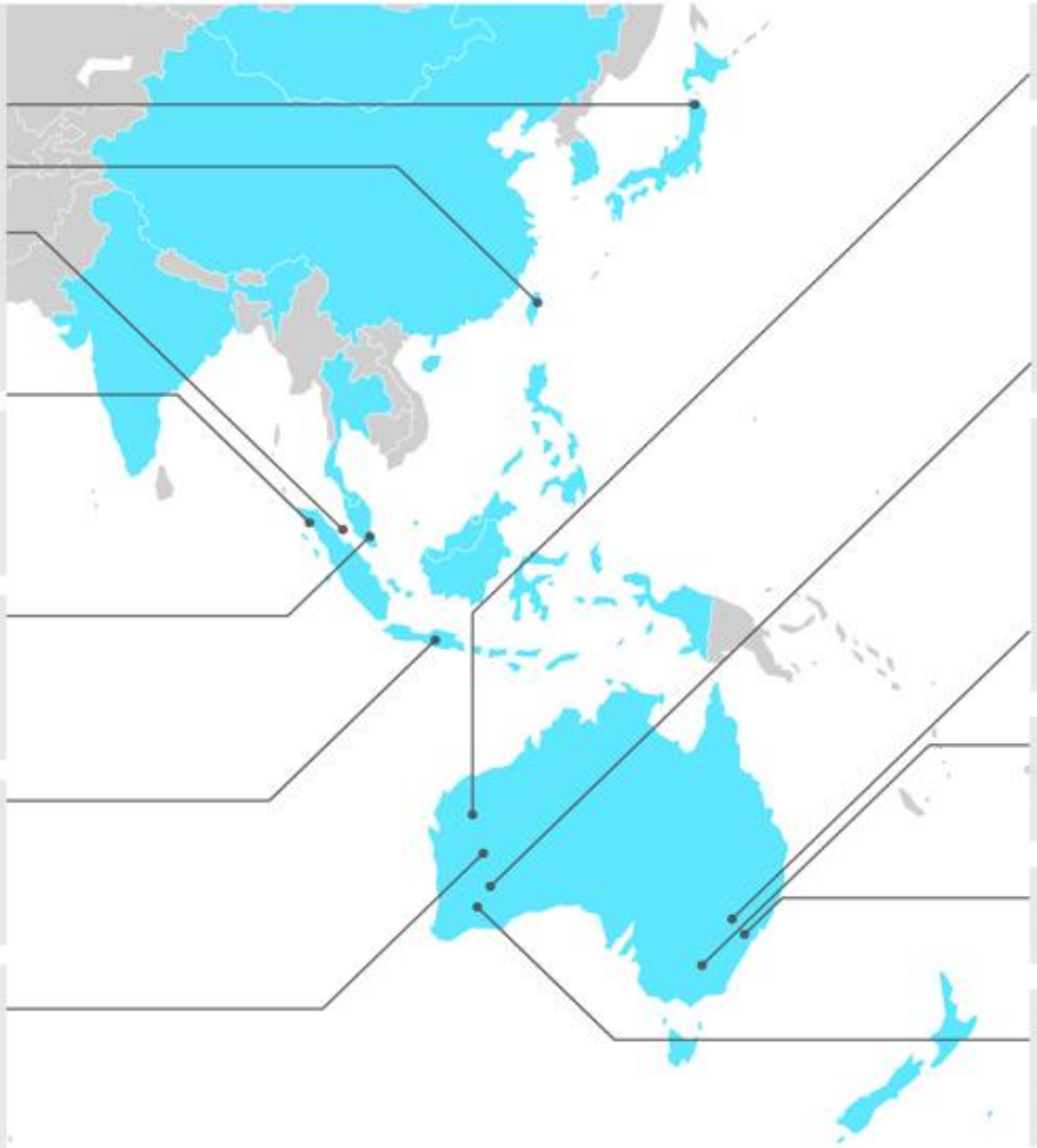
POWER
Global Data Centers
Jacobs is supporting multiple global technology and software companies with the provision of sustainable energy advisory and engineering services globally. This includes innovative cooling and hydrogen storage solutions.

PRODUCTION, STORAGE, EXPORT
Geothermal Hydrogen concept and Feasibility Studies
Geothermal hydrogen feasibility studies for a number of sites across Indonesia for a confidential client

HYDROGEN TO POWER
Data Centers Energy Offtake Advisory, Singapore
Hydrogen, CCS and Interconnector market and supply chain analysis, undertaking H_2 export developer interviews for shortlisted projects, plus establishing offtake discussions

PRODUCTION, STORAGE, EXPORT
GIZ & Pertamina
Geothermal hydrogen production concept studies including assessment of geothermal resources across Indonesia and detailed market supply chain analysis

PRODUCTION, STORAGE, EXPORT
Green Hydrogen and Ammonia Investment Advisory
Technical and environmental due diligence for the Singapore national investment fund in relation to multi GW green hydrogen projects in Australia and the Middle East



Santos Carnarvon Blue Hydrogen
Jacobs provided the Environmental approvals and stakeholder management strategy for hydrogen production and offshore CC Santos Carnarvon Blue Hydrogen Project

PRODUCTION, STORAGE, EXPORT
WA H_2 Feasibility Study
Conducted a feasibility study to screen renewable and storage technologies and select feasible concepts to support production of green hydrogen across 5 deep water port locations in Western Australia

PRODUCTION, STORAGE, DISTRIBUTION
Hydrogen Hub Partnership
Jacobs serves as equal partner, project manager and delivery lead along with two of our key energy and water clients. Ultimate capacity in the range of 50-100 MW

HyP Murray Valley
Jacobs conducted energy market modelling for AGIG re integration of a 0 MW electrolyser to be blended with natural gas at volumes of up to 10% H_2.

Yarra Valley Water
Preliminary engineering design, cost estimation and economic modelling for a 2.5 tonnes per day (6 MW) renewable hydrogen plant

Energy Port of Newcastle study
To assess the pathways available to realise the vision for the Port of Newcastle as a future renewable energy hub, covering Hydrogen, solar, wind, tidal and biomass energy sources

POWER
Green Hydrogen Hub Power Transmission, AGIG
Developing designs for power supply, transmission and distribution of the Wodonga hydrogen hub

LH_2 STORAGE, EXPORT
Liquified Hydrogen Export
Feasibility study for the storage and export of liquified hydrogen from a port in Eastern Australia

PERMITTING
Green Ammonia Study
Reviewed environmental baseline information and develop an approvals strategy for the proposed renewable H_2 ammonia production facility at four potential locations in Western Australia

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