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Hydrogen

A Critical Energy Carrier to Achieve Net Zero

The Energy Transition

Net Zero Greenhouse Gas Emissions

At Bechtel, we are committed to supporting our customers and communities to progress towards the goal of net zero greenhouse gas emissions. We work on energy transition projects to support our customers to decarbonize their existing assets or to develop new assets that progress society's goal of net zero emissions.

Supporting the delivery of net zero ambitions through:

- Carbon capture (pre, post and direct air)
- CO₂ gathering networks & terminals
- Renewables & clean energy storage
- Nuclear power
- Low-carbon hydrogen & ammonia
- Low-carbon advanced fuels (sustainable aviation fuels, methanol)

Supporting the Path to Net Zero

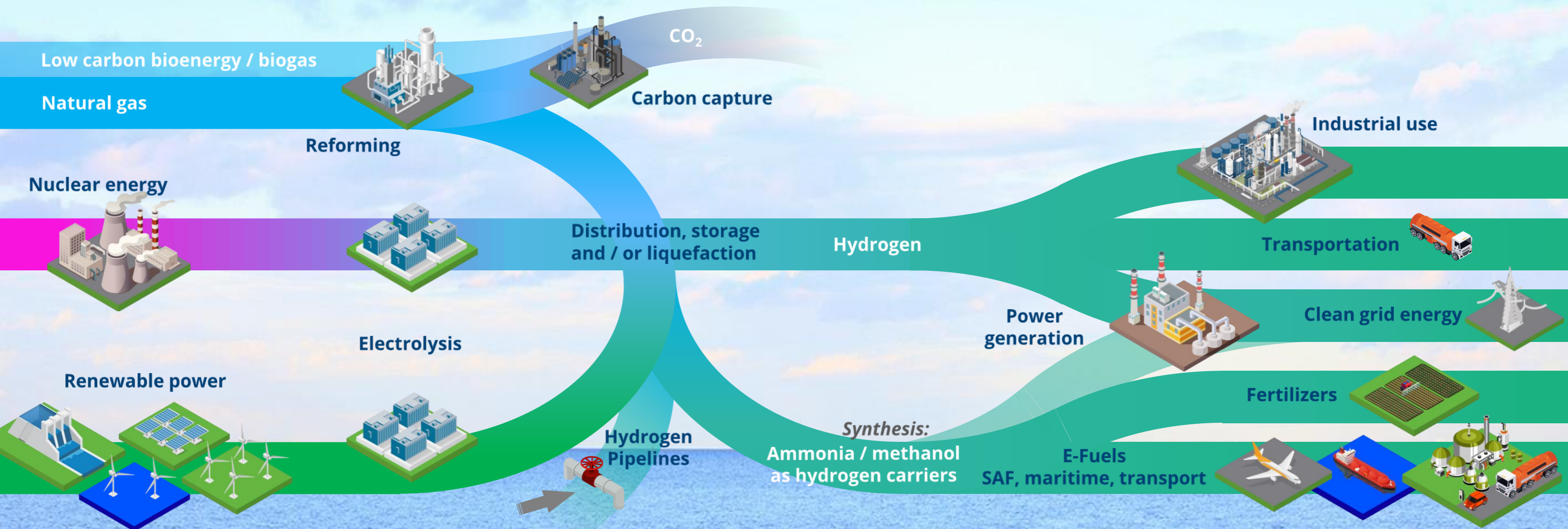
Providing Full Breadth Of Services Across The Hydrogen Value Chain

Engaging an EPC practitioner from the early stages has proven to help realize a projects potential from early stages, by evaluating the right technologies and options when design is most efficiently influenced.

Dedicated hydrogen Subject Matter Experts provide an EPC lens for engineering, embedding a design-right-first-time ethos from early stages such as:

- Technology assessments
- Project definition
- Plot identification
- Techno-economic evaluations

Bechtel's Experienced Teams Offer Support Across The Full Value Chain:



What Bechtel can do for you

Full scope of services

Masterplanning, studies, Pre-FEED, FEED, EPC

Capability spanning the full hydrogen value chain

Renewable power generation, hydrogen production, storage, liquefaction, distribution, synthesis and utilization

Leveraging EPC insight and constructability into every stage

Modularisation, constructability, T&L

Technology neutral

Able to work across the spectrum of technologies without limitations to specific OEMs and vendors

Quality of estimate

Approach to estimating relies on in-house developed estimating tools, fed by our database of equipment and bulk materials, purchase orders, and market pricing analysis, supported by tried and tested estimating procedures. Benchmark analysis against as-builts.

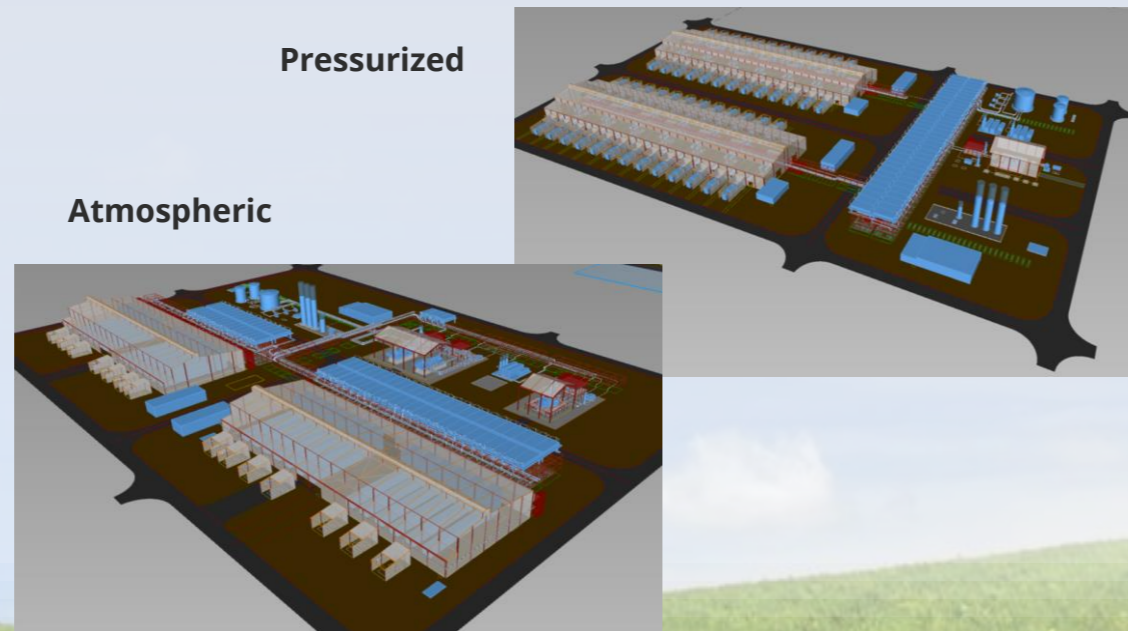
FEED level template models

In-house developed templates designs for green hydrogen facilities, adjustable to any OEM design.

- Facilitates Pressurized and Atmospheric alkaline options
- Scalable, modular designs
- Inclusive of electrical systems, electrolyzer technology, compression and gas conditioning.
- We have also developed options for PEM and liquefaction.

Improved certainty:

- Accelerated engineering process
- Reduced engineering cost
- Certainty of design
- Better certainty of TIC
- Pre evaluated a range of technologies and package vendors
- Long lead procurement awareness
- Supports early procurement activities
- Improved material quantities and costs
- Constructability insight
- Resource requirements



BUILDING FOR THE FUTURE FROM EXPERIENCE

- ? Reforming technology holds an estimated 95% market share **BECHTEL** Leveraging decades of H2 experience in refinery / chemical processes
- ? Reducing Carbon Intensity (CI) via the application of Carbon capture to SMRs / ATRs **BECHTEL** Long history with reforming, pre-combustion & post combustion carbon capture technology / licensors, projects, & engineering
- ? Low carbon H2 derivatives market growth (ammonia, methanol, liquid organic hydrogen carriers) **BECHTEL** Decades of experience in process facilities
BECHTEL Long relationships on a technology agnostic basis with all key process licensors
- ? Estimated global installed H2 electrolyzer capacities are forecast to grow rapidly (single-digit GW today, to multi-digit GW by 2030) **BECHTEL** Developing 7GW+ of electrolyzer-based projects with relationships with all key vendors
- ? To achieve larger scale, facilities must scale from 10s MWs to GWs **BECHTEL** Engineering and designing facilities that integrate large numbers of electrolyzers and associated balance of plant to achieve GW scale electrolytic hydrogen (and downstream derivatives)
- ? Supply of low carbon power must increase to supply the electrolyzers **BECHTEL** Builds on 26GW+ of installed renewable power plants
- ? Scaling electrical distribution and control systems for GW scale electrolyzer facilities **BECHTEL** Three decades of electrical distribution system design, installation and operational experience from large electrolyzer modules used in metals facilities.
BECHTEL Experienced engineering electrolyzer module power solutions, such as the rectification process for DC supply
- ? Water scarcity in opportunistic renewable energy-rich locations **BECHTEL** Water treatment plant experience (75+ built desalination and deionization plants) often in remote and challenging locations.
- ? Storage & export facilities for H2 and derivatives at larger scale **BECHTEL** Long history of specialized storage and marine export facility development, which has developed large scale H2 sphere and ammonia tankage design

Low Carbon Intensity Hydrogen Project Development



EPC Green Hydrogen Production Facility Canada. CM of the EPC phase of an electrolyzer plant incorporating Cummins electrolysis technology



EPC Alba Aluminium in Bahrain. One of the world's largest aluminum smelter facilities, incorporating 5km of electrolyzer modules



EPC Cutlass I&II Solar PV projects totaling a combined 420MWDC in the US



Shannon Foynes Port Company, Power-to-X green ammonia networks, Ireland Masterplan



Design development to support land acquisition & permitting for a blue ammonia facility in North America. Layouts included surface and subsurface facilities and various transportation options



Egypt masterplanning. Providing expertise to support decarbonization of select downstream facilities in Egypt

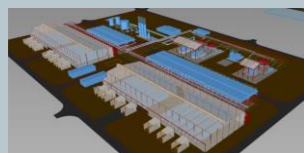


Biomass to marine fuels concept study project. Converting woody biomass into low carbon intensity methanol of ammonia for marine fuels

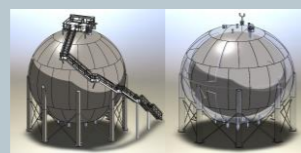


Detailed project execution plans for a multi-hundred tpd electrolyzer-based hydrogen production and liquid hydrogen export facility.

FEED level templated Bechtel designs:



Scalable Green Hydrogen template facility designs to FEED level for Pressurized and Alkaline options adjustable for all OEMs



FEED replicable cryogenic (LH2) storage spheres template design



Velocys e-Alto e-Fuels feasibility project in the UK using renewable electricity to make sustainable aviation fuels from carbon dioxide and hydrogen



Electrolyzer Comparison Study, evaluating two suppliers (Pressurized PEM vs Alkaline) for implementation in a proposed 1.8 GW facility on the US Gulf Coast.



Numerous feasibility studies for hydrogen, ammonia and methanol projects in the US & Canada, leveraging renewables, nuclear power, or power purchases



Green ammonia tank in the UK. Best available technology study and FEED for 1x low temp 80,000m3 storage tank



FEED producing low carbon hydrogen from an innovative municipal waste diverted from landfill in the US



Velocys Altalto FEED in the UK. Producing sustainable aviation fuel from municipal waste



Green hydrogen and ammonia plant, Pre-FEED exploring GW scale hydrogen production and ammonia synthesis, from green energy solutions in Africa



Green hydrogen and ammonia plant Pre-FEED in South America. Scope includes engineering and permitting support, for the 3GW green ammonia production facility



HIF Matagorda e-Fuels, carbon neutral methanol via electrolysis and hydrogenation, with Methanol-to-Gasoline (MTG), US. Scope included Pre-FEED and FEED



US Gulf Coast Blue Hydrogen and Ammonia, FEED. Large-scale multi-train facility incorporating carbon capture.



FEED for Balance of Plant (BOP) for a 15 tpd hydrogen purification and liquefaction facility to provide hydrogen as transportation fuel.



Pre-FEED for liquefaction, storage, marine terminal cryogenic export from a Hydrogen Liquefaction Facility. Phased execution for multi hundred tpd throughputs including location assessment.



Decarbonization project investigating green energy / renewables / electrolysis and export in North America, from Masterplanning to Pre-FEED

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