

Reducing hydrogen project costs through standardization

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Our global experience

London, UK

- Power and networks, refining, chemicals
- Hydrogen Strategy, commercial
- Blue H₂ production, supply chain
- Concept/FS/FEED/Delivery
- Carbon Capture

India

- Digitally enabled delivery of H₂ projects (pre-and post FID)

Houston, Atlanta, various

- Refining, chemicals
- Blue hydrogen
- Carbon capture

The Hague, The Netherlands

- Power and networks, refining, chemicals
- Hydrogen Strategy, commercial
- Green H₂ production, supply chain
- Concept/FS/FEED/Delivery
- Carbon capture

Brisbane, Melbourne, Perth

- Power and networks, refining & chemicals, MMM
- Hydrogen strategy, markets and economics
- H₂ production, supply chain
- Concept/FS/FEED/Delivery
- Carbon Capture

Hydrogen overview

194

Hydrogen projects

36 GW

Largest green hydrogen electrolyzer studied, combined with offshore wind

3,260+

Projects in the Energy Transition

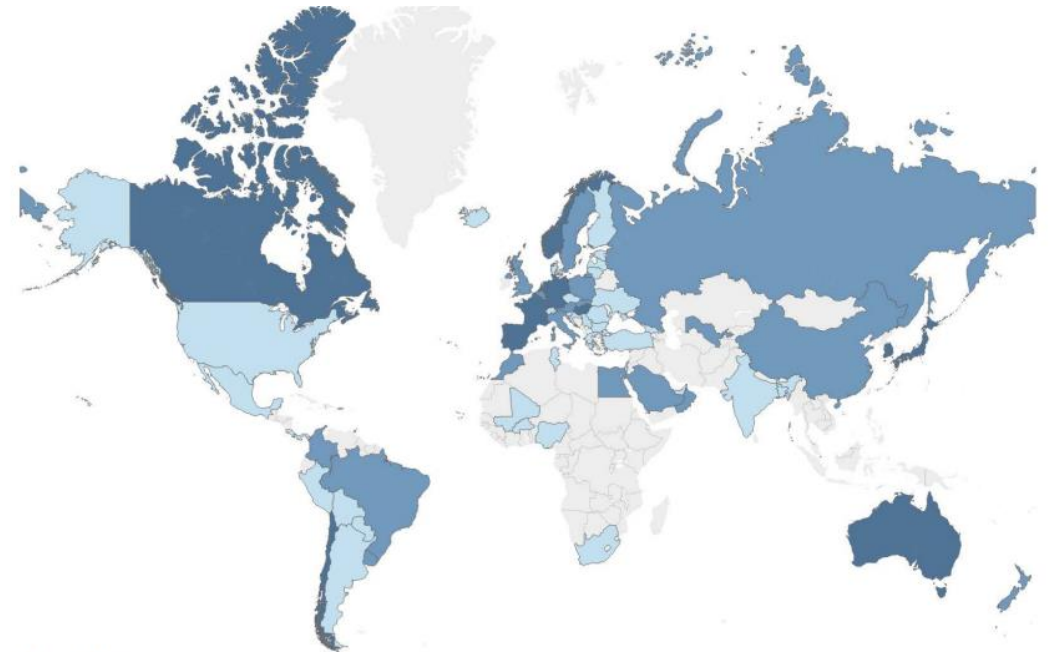
Many of the world's largest hydrogen projects

Providing engineering services

Global acceleration

Countries are increasingly embedding hydrogen strategies

- Cost of renewables has fallen
- Electrolyser CAPEX reducing and efficiencies increasing
- Energy security is firmly alongside decarbonisation in importance in the energy transition, raising the hydrogen expectation further



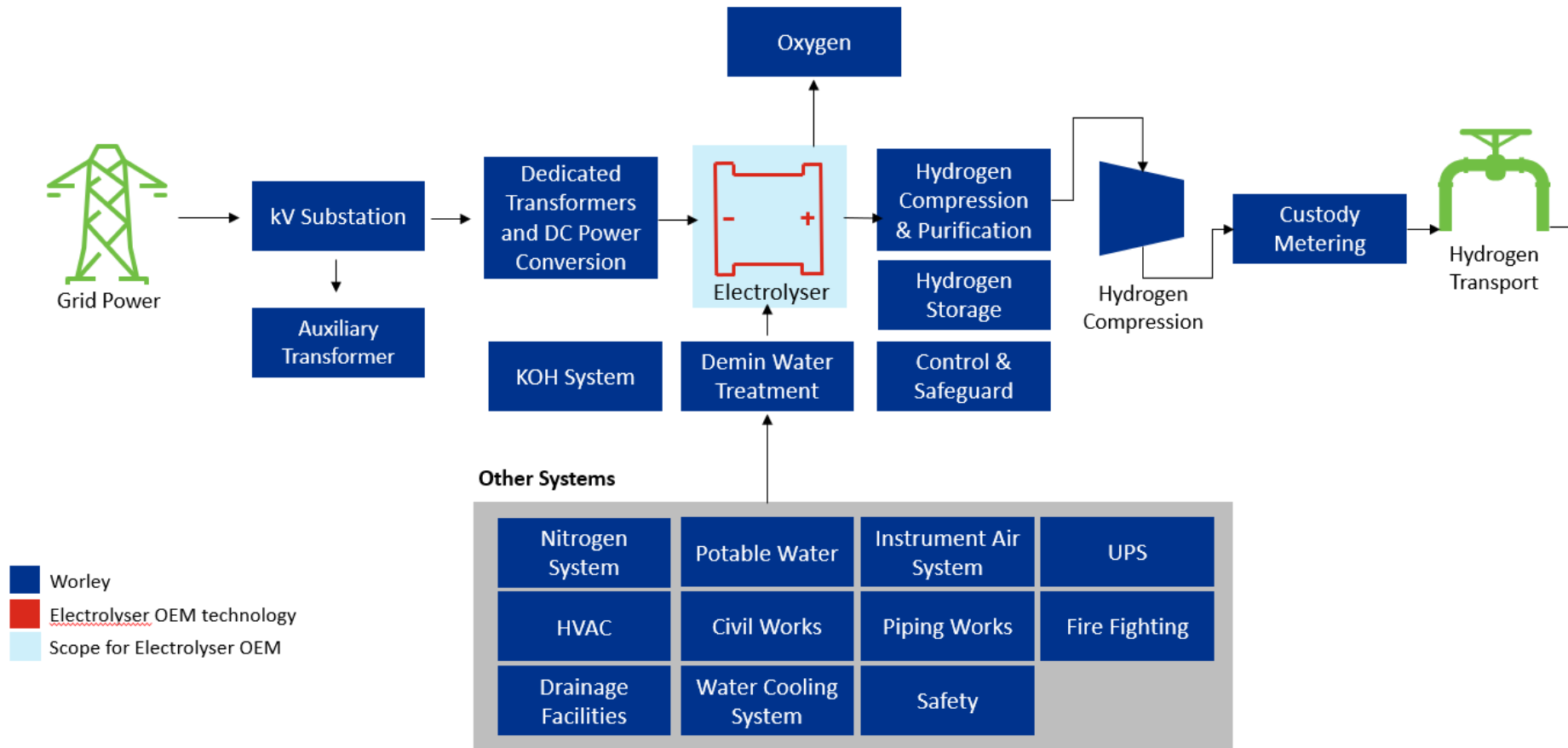
State of play

- Published national strategy
- National strategy in preparation
- Policy discussions/Initial demonstration projects

Source: World Energy Council

Project Scope Development

Digital Modular Green Hydrogen Plant

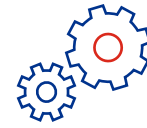
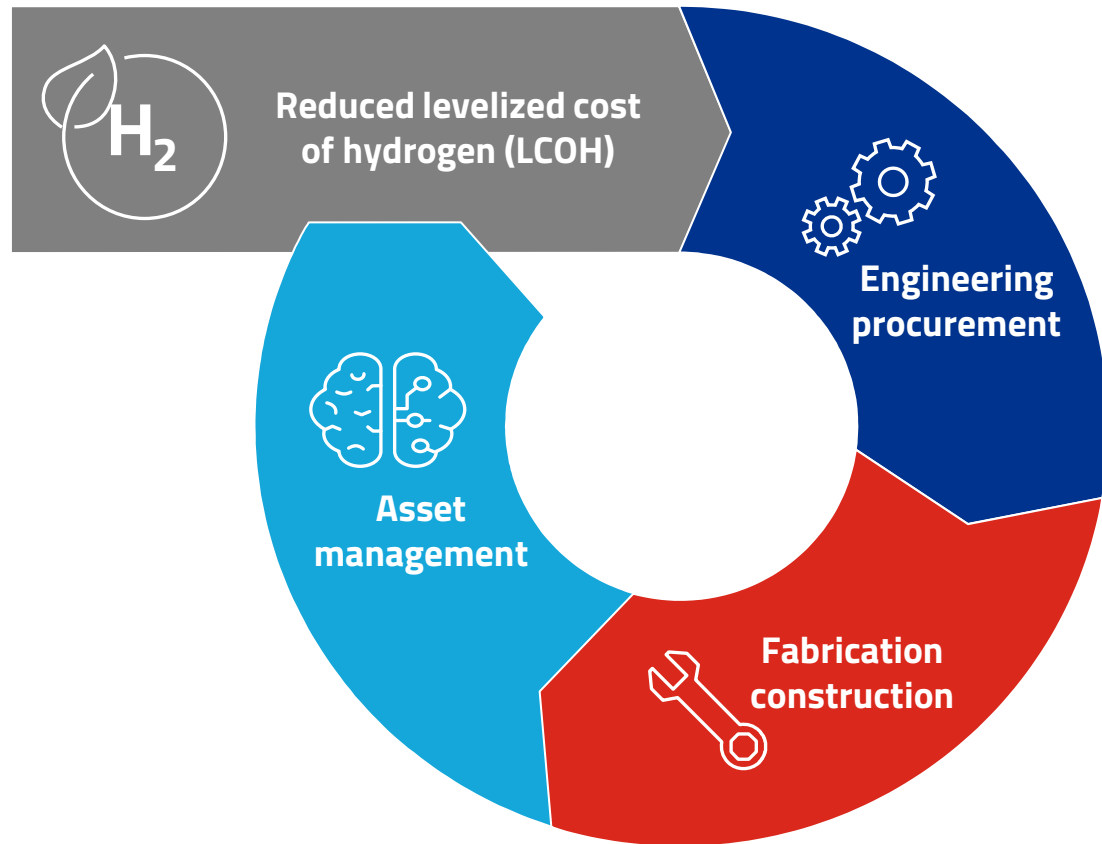


Innovate towards:

- **Scalable**, from 20MW to 200MW and into 1GW+
- **Modular Engineered**, to facilitate the scalability
- **Modular Fabricated**, to allow agile procurement and construction
- **Digitalized**, to give the client a digital twin and cloud based operating strategy
- **Flexible**, to make it adaptable to different technologies
- **Optimization**, based on a selected technology

Connected delivery model

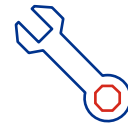
Optimized engineering and repeatable fabrication with the operating asset in mind



Engineering and procurement

Adopting a modular approach that simplifies optioneering and accelerates engineering to deliver a standardized design.

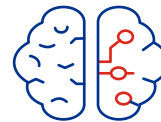
Fabrication focused



Fabrication and construction

A connected fabrication, delivery and installation solution which accelerates asset delivery timelines.

Operations focused



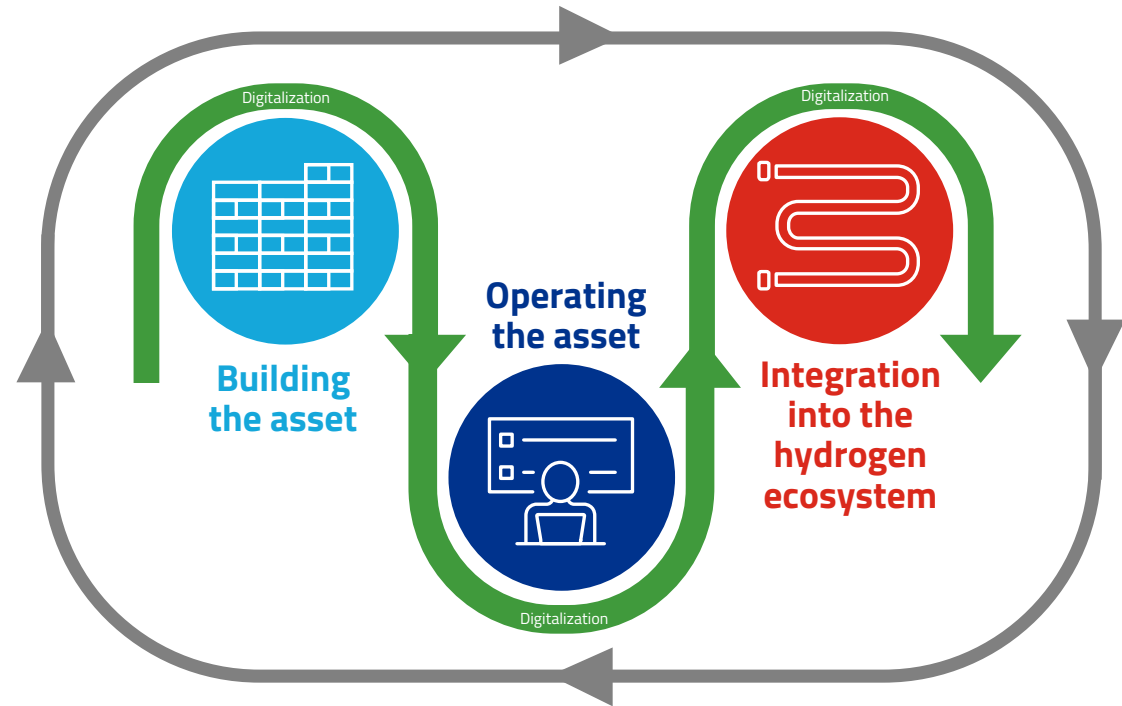
Asset management

Utilizing a data driven approach with digital technology to deliver connected assets with smart operations functions.

Efficiency focused

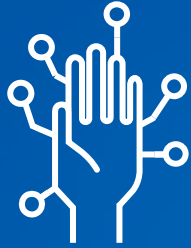
Driving towards commercial viability

The ABB/IBM/Worley collaboration improves all three areas... increasing commercial viability



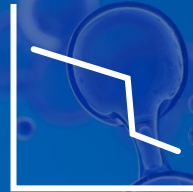
Strength in collaboration

1



An integrated digital approach considering the asset lifecycle and integration into the broader business ecosystem

2



Driving towards hydrogen with a levelized cost of \$2/kg

3



Solutions which help resolve business challenges for the hydrogen market

Electrolyzer OEMs

Polymer electrolyte Membrane (PEM) Technology

- **HYDROGENICS (Cummins)**
- **NEL Hydrogen**
- Plug Power
- **ITM**
- Elogen
- **Siemens**
- H-TEC SYSTEMS
- Hydrogen Pro/TianJin Mainland
- Hoeller
- Idroenergy Spa

Alkaline Technology

- **ThyssenKrupp**
- **NEL Hydrogen**
- **Sunfire / IHT**
- **GHS**
- **Cummins**
- **McPhy**
- KOBELCO
- **THE**
- **Peric**
- Hydrotechnik
- **Cockerill Jingli Hydrogen**
- Asahi Kasei

Solid Oxide Electrolysis Cell (SOEC) Technology

- **Sunfire**
- FC Energy
- TOSHIBA
- **Haldor Topsoe**

Anion Exchange Membrane (AEM) Technology

- **Enapter**
- Evonik

The electrolyzer companies we have worked with are indicated in **Blue**.

Selected Clean Hydrogen Projects: from concept to completion



Offshore Wind Farm and 100MW Electrolyzer Facility

760MW Offshore Wind farm, Netherlands

- Worley acted as a **technical counsel** involving the development of a 760MW offshore wind farm and a **100MW** hydrogen electrolyzer facility
- Worley's role involved a business model for the hydrogen production
- We built a financial model which determined the levelized cost of hydrogen
- Identified potential hydrogen offtakers and building a joint business case.



Nouryon Alliance

Netherlands, Nouryon/Nobian

We are working with Nouryon to scale of hydrogen production to build a carbon-free Netherlands. Currently we are workin on three projects:

- Djewels 1, 20MW** electrolysis plant for production of green H2 for bio-methanol FEL 1, FEL 2 and currently **FEED completed**
- Djewels 2, concept study for 50MW** electrolysis plant for production of bio-kerosene for sustainable jet fuel
- Hermes, 100MW project in concept study** phase to decarbonize steel production



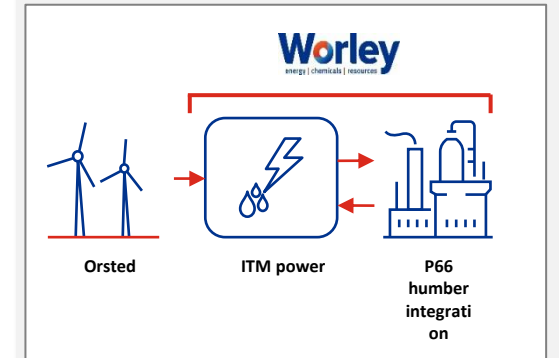
Green Hydrogen Plant utilizing Offshore Wind

Shell 200 MW Maasvlakte, Netherlands

We are working with Shell in the Netherlands to develop a **200MW** green hydrogen plant in the Maasvlakte area in the Port of Rotterdam.

Our scope incorporates all different moving parts:

- Integration of electricity supply** from an offshore windfarm
- Technology selection and OEM selection in an integrated team
- Integration of the 200MW electrolyzer OEM** design in the conceptual design of the plant
- The design of the balance of plant** and infrastructure
- We are responsible for **Integrating the green hydrogen into the Shell Pernis refinery** as part of a decarbonization strategy.



Green Hydrogen Plant utilizing Offshore Wind

Gigastack member Phillips 66, UK

We are helping Gigastack consortium member Phillips 66 by performing the Engineering for a **100MW** green hydrogen plant in the UK.

Our scope incorporates all different moving parts:

- Desalination / water treatment** to produce ultra-pure water feedstock
- Integration of electricity supply** from Ørsted's Hornsea 2 windfarm
- Integration of the 100MW electrolyzer.** (ITM Power)
- The design of the balance of plant** and infrastructure
- We are responsible for **Integrating the green hydrogen into the Phillips66 Humber refinery** as part of a decarbonization strategy.

Selected Clean Hydrogen Projects: from concept to completion



Green Energy Oman Oman

We are supporting Green Energy Oman (GEO), an international consortium, to develop a 25-gigawatt (GW) low-carbon fuels project.

- Concept feasibility study services to further develop and challenge GEO's defined green hydrogen energy project.
- Optimize 25 GW of wind and solar generation, transforming this renewable energy into green hydrogen, and the production, storage, and export of ammonia.
- Produce 1.8 million tons of low-carbon green hydrogen which can produce up to 10 million tons of green ammonia per annum.
- Identify opportunities to enhance in-country value delivered from the expected 10-year project implementation period.



FlagshipONE power-to-fuel project Liquid Wind

Worley are providing front-end engineering design services for the eMethanol facility which will be constructed in Örnsköldsvik. We will support the Liquid Wind Consortium to plan the efficient integration of the technology components and the union with the host power station, Övik Energi. The Consortium also includes Alfa Laval, Carbon Clean, Haldor Topsoe and Siemens Energy.

Liquid Wind plans to establish 500 facilities by 2050 and the collaboration with Worley will support this ambition. Worley will, together with the consortium partners, design a standardised and modular facility concept, that can be efficiently replicated and assembled for subsequent flagships. During the design phase a digital twin will be established using a COMOS engineering database.



Green Marlin Project – Scoping Study EI-H2, Ireland

EI-H2 are the front-runner for developing commercial scale Green Hydrogen facilities in Ireland today.

There are a number of strategically located sites under development in the EI-H2 portfolio including Green Marlin, located in Bantry Bay County Cork.

Worley executes a concept/feasibility study to support the business case by

- Developing an outline of the process system
- Estimating a potential levelized cost
- Drafting the Initial schedule
- Documenting the key risks
- Developing a scope of work for the next phases



Refinery 150 MW green H2 project Confidential customer, The Netherlands

Assessment of the considered implementation of a 150 MW green hydrogen plant into an existing refinery to substitute/complement the hydrogen generation of the steam methane reformers in the facility.

The green hydrogen plant will use electrolysis technology, fed by electricity generated in an offshore wind facility, to produce around 23,000 tons a year of green hydrogen and contribute to the reduction of the CO2 emissions of the refinery.

We support our customer to complete the feasibility assessment including electrolysis technology review, build-up a sound business case, obtain the required internal approvals and mitigate the risks associated to the development of this project

Worley
energy | chemicals | resources