



# HYDROGEN BROCHURE

DECEMBER 2022

IDEAS | PEOPLE | TRUST

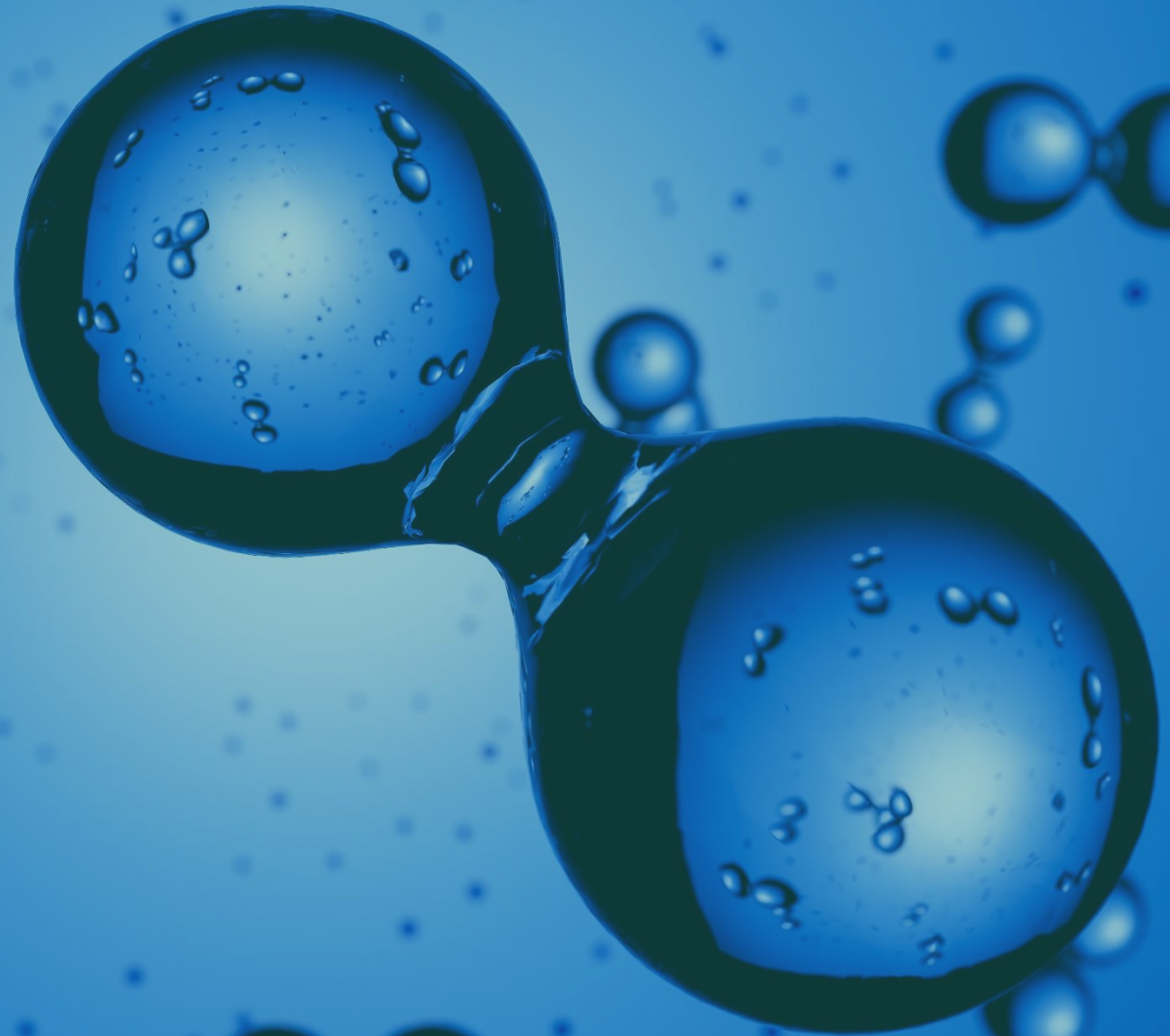


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# HYDROGEN OVERVIEW

Hydrogen is a chemical molecule which bonds two hydrogen atoms together, and it can be abundantly found in water, natural gases, plants, animals, and oil, but always form parts of other compounds. In nature, Hydrogen exists as a colourless and odourless gas, and possesses high energy content.

So, why is everybody talking about hydrogen, and how can we take advantage of its characteristics to significantly benefit technology and society, including tackling global warming?

## OPPORTUNITIES

When hydrogen burns, it produces zero carbon emissions. If we can decarbonise many traditional processes or technologies by using hydrogen instead, or produce hydrogen from methods that are not carbon-intensive, then contributions to greenhouse gas emissions can be significantly reduced. That is why hydrogen energy is being viewed as increasingly important in the fight against the climate crisis.

In addition to decarbonisation, another major opportunity that may be realised through utilising hydrogen is that due to its abundant existence in nature, the reliance on overseas commodities required for energy (e.g. natural gas, oil) is lessened, and countries may be able to better utilise domestic energy sources. This should go some way to preventing the destabilising energy crises caused by events such as the Russian invasion of Ukraine, with countries moving towards being more reliant on their own power sources.

# HYDROGEN PRODUCTION

## Blue hydrogen vs Green hydrogen

There are various methods to produce hydrogen, with each method having a distinct colour assigned to its name.

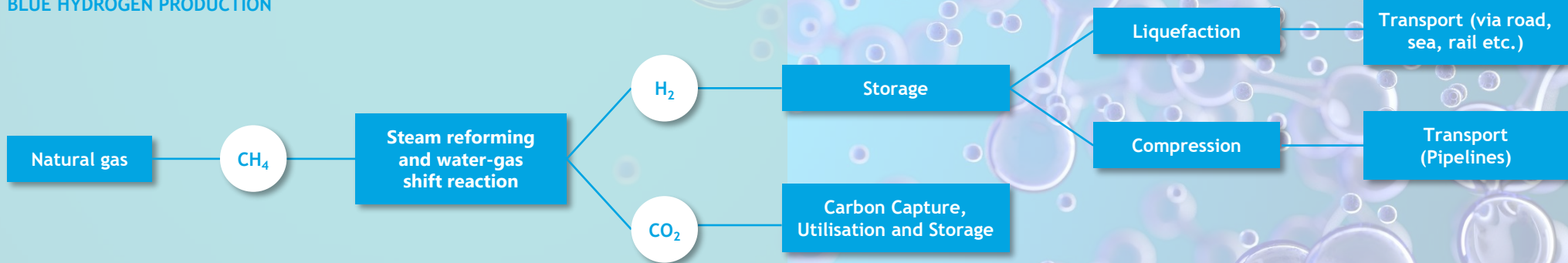
Methods based on Steam Methane Reforming, (separating hydrogen from natural gas (CH<sub>4</sub>)) make up approximately 95% of today’s hydrogen production. These methods are known as blue and grey hydrogen.

For hydrogen to be a truly sustainable, renewable energy source, the world must move to green hydrogen, which currently only accounts for less than 1% of all hydrogen production. This method separates hydrogen from water (H<sub>2</sub>O) through electrolysis, where the electrolyzers are powered by renewable electricity (e.g. solar, wind).

The advantages and disadvantages of blue and green hydrogen:

BLUE HYDROGEN	
<b>SOURCE</b>	Natural gas/methane (CH <sub>4</sub> )
<b>PROCESS</b>	Steam Methane Reforming (SMR) + Carbon Capture and Storage (CCS)
<b>ADVANTAGES</b>	▶ Low production costs and highly scalable.
<b>DISADVANTAGES</b>	▶ Continuing to extract fossil fuels ▶ Concerns over carbon leakage ▶ Blue (and grey) hydrogen accounts for ~95% of all hydrogen production.

### BLUE HYDROGEN PRODUCTION



# HYDROGEN PRODUCTION

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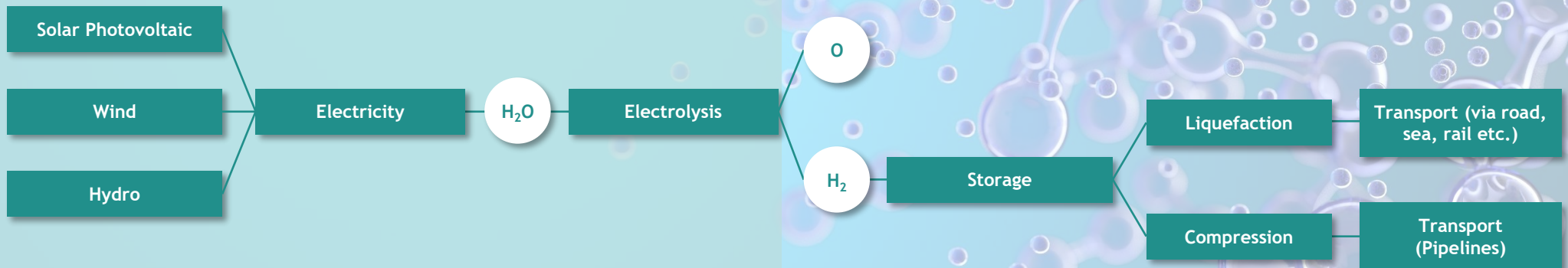
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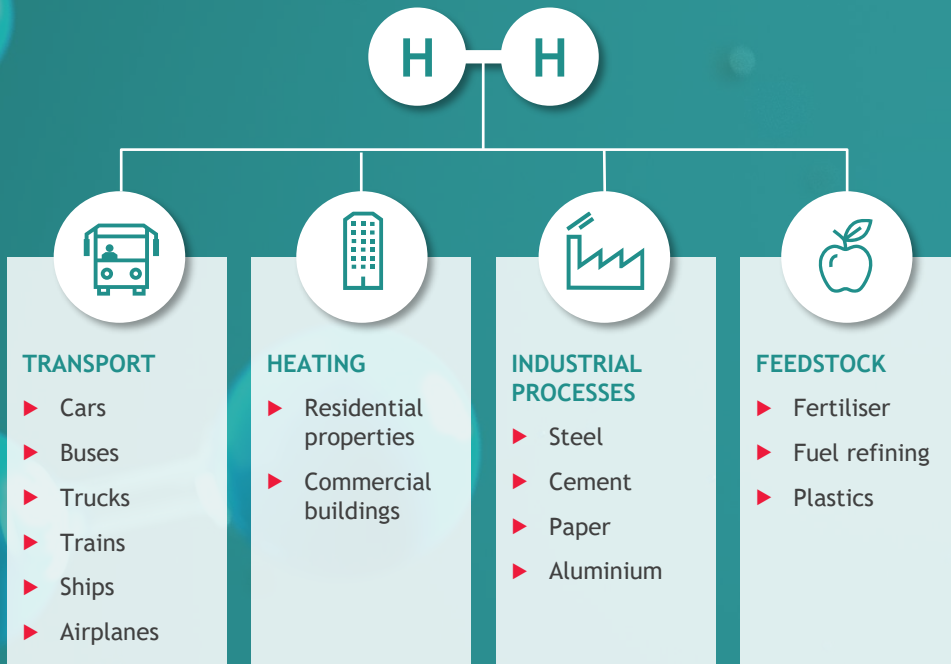
The advantages and disadvantages of blue and green hydrogen:

GREEN HYDROGEN	
<b>SOURCE</b>	Water (H <sub>2</sub> O)
<b>PROCESS</b>	Renewable electricity powers an electrolyser to split water into H <sub>2</sub> and O
<b>ADVANTAGES</b>	▶ Zero carbon emissions at production.
<b>DISADVANTAGES</b>	▶ Global shortage of renewable electricity ▶ < 1% of hydrogen is produced via green hydrogen.

### GREEN HYDROGEN PRODUCTION



# HYDROGEN TECHNOLOGIES AND APPLICATIONS



### UK HYDROGEN STRATEGY

To meet their 2050 net-zero target, the UK government announced the Hydrogen Strategy in August 2021, which sets out a plan to become a world leader in producing low-carbon hydrogen. The target was initially set at 5GW of production capacity, which was doubled to 10GW in April 2022. The produced hydrogen will then be used for vehicles, appliances, industrial process, and feedstock to produce chemicals.

To achieve this, the government has ramped up grant funding in this emerging sector, introduced incentives, and authorised hydrogen projects across the country to establish hydrogen ecosystems.



### GLOBAL WARMING

Given the UN’s damning report on carbon cutting progress since COP26 in 2021, which stated that ‘no credible pathway’ remains to meet the 1.5 degree global warming threshold, there is even more pressure on governments and industries to go further and faster when it comes to mass decarbonisation. The development of clean hydrogen power and technologies are one of the most important pathways to cutting emissions.

<sup>1</sup> <https://www.benchmarkminerals.com/energy-density-and-the-challenges-of-electrification-for-heavy-duty-vehicles/>

# HYDROGEN TECHNOLOGIES AND APPLICATIONS



## HYDROGEN POWERED APPLIANCES

Another area that could take advantage of hydrogen is boilers and other appliances. Currently, residential properties and commercial buildings typically use natural gas/methane to provide heat, but the industry is looking at using a blend of natural gas and hydrogen, or even wholly substituting in hydrogen for natural gas.

In the case of a boiler, natural gas is burned to create a hot flue gas, which then heats water to heat buildings. As with other technologies, the advantage of using hydrogen is that when it is burnt to provide that hot flue gas, it does not emit any CO<sub>2</sub> and the only by-product is water.



## INDUSTRIAL PROCESSES

Industrial processes such as the production of steel, cement, and paper, contribute significantly to greenhouse gas emissions. Steel making alone contributes to nearly 10% of all human-made greenhouse gas emissions. Pioneering processes to introduce hydrogen into the production process to provide the same function as carbon (e.g. converting iron ore into metallic iron in steelmaking) are in development.



## HYDROGEN FEEDSTOCK

Existing processes that require hydrogen as a feedstock (e.g. ammonia (NH<sub>3</sub>) in fertilisers, hydrogen in plastics, hydrogen for oil refining), can now begin to source hydrogen from greener, more sustainable production processes (e.g. green hydrogen) rather than carbon-intensive methods (e.g. grey hydrogen).



## HYDROGEN POWERED VEHICLES

One of the key technologies to benefit from hydrogen is transport. Using hydrogen fuel cells converts hydrogen and oxygen into electricity, which is then used to power motors.

The larger the vehicle, the more benefit there is to leveraging hydrogen fuel cells. Currently, heavier vehicles are harder to electrify as they require greater power with increasing payloads, and at an exponential rate<sup>1</sup> relative to lighter duty vehicles. As an example, the kWh/km requirement for heavy duty trucks and buses is approximately 1.1-1.3 kWh/km, compared to 0.2 kWh/km and below for passenger cars.

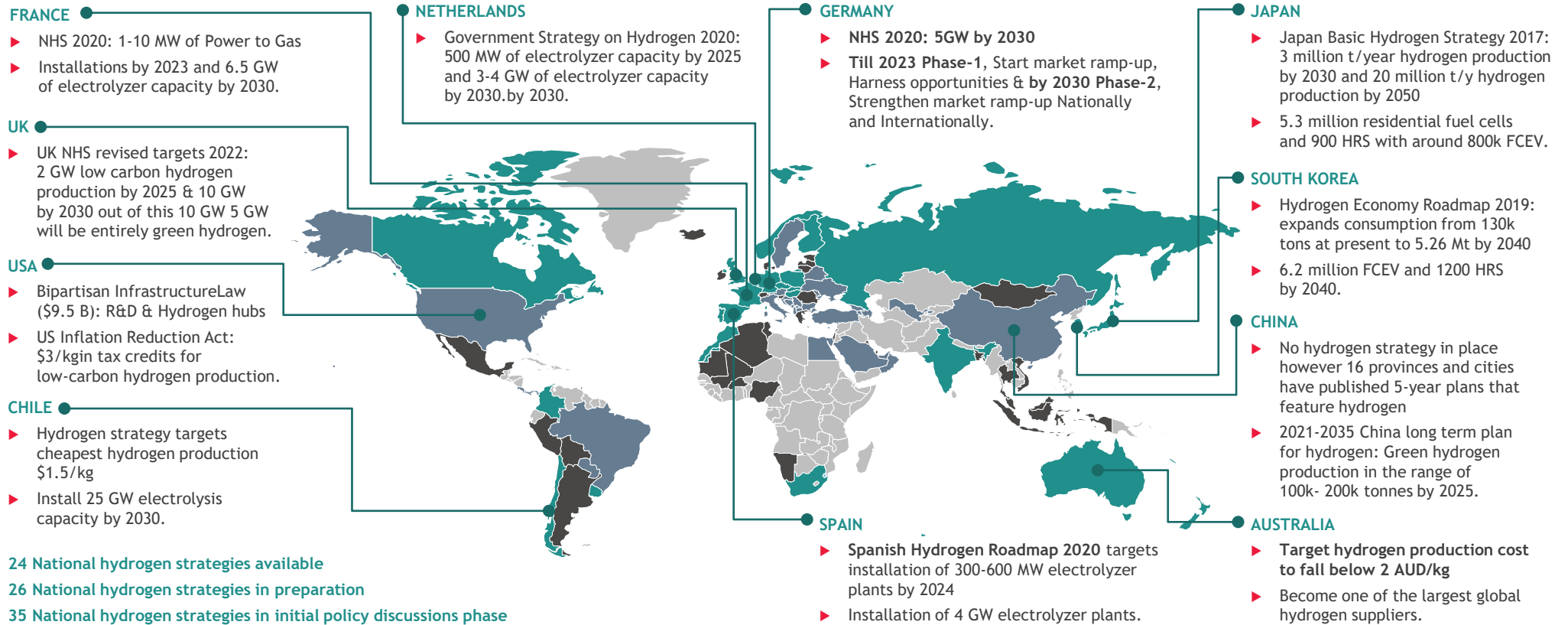
In order for heavier vehicles to travel 800km without recharging, it would require an electric battery of roughly 5,000 kg, meaning they take a 5-10% payload loss compared to a diesel-fuelled vehicles. Hydrogen, being a lighter energy carrier compared to electricity, becomes increasingly beneficial as weight of the vehicle increases.

Vehicles powered by hydrogen frees up weight to transport more cargo or passengers (rather than allocating that weight to electric batteries) and allows vehicles to travel longer distances with less refuelling. While it may be some time until we see hydrogen powered buses and cars on our streets, this is a key focus of the industry, and as investment increases, progress will come quickly.

# GLOBAL EFFORT

## International Hydrogen Strategies

Countries around the world have enacted hydrogen strategies with a range of deadlines, production capacities, production methods, and production costs. This will create a healthy international hydrogen race, as well as expanding the industry’s knowledge which may be exchanged globally to progress hydrogen technology.



Map courtesy of Power Technology Research.



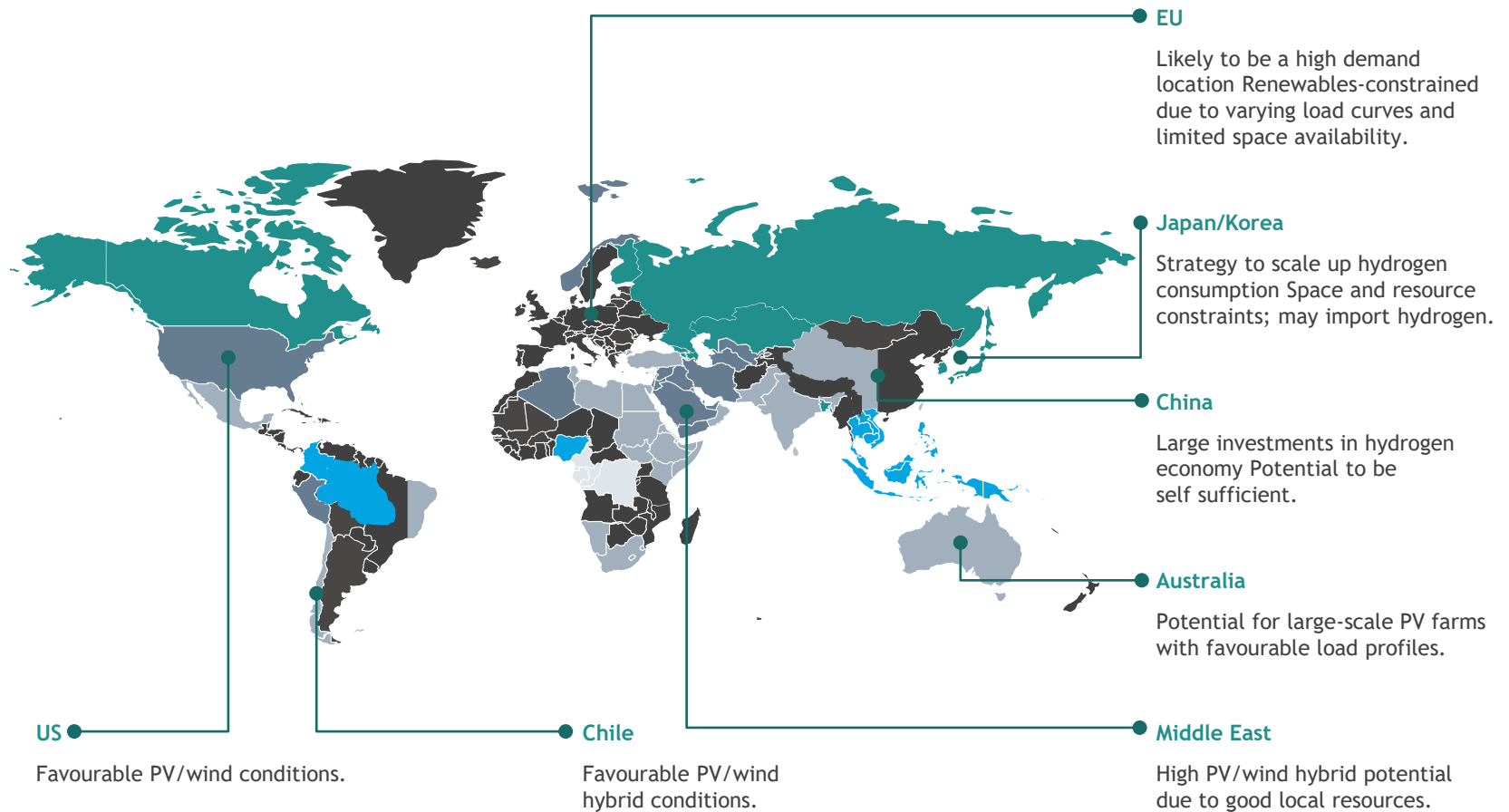
# GLOBAL EFFORT

## Key Countries

### DEPLOYMENT OF GREEN H<sub>2</sub>

- Optimal renewable and low-carbon resources
- Optimal low-carbon resources
- Average low-carbon resources
- Optimal renewable resources
- Average renewable resources

- ▶ Presently, location of the plant is a primary enabler of Green H<sub>2</sub> production
- ▶ Production costs are influenced by cost of renewable energy and cost of the electrolysis unit (and to a lesser degree, the utilisation factor)
- ▶ As costs fall, Green H<sub>2</sub> can achieve cost parity with blue H<sub>2</sub> by 2030.



# THE CHALLENGES OF HYDROGEN ECONOMY

There are still numerous hurdles to leap before hydrogen production and technologies can be widely rolled out. Below is a summary of the main challenges that the industry faces.

## TECHNOLOGICAL



Available technology is currently unsuitable for the hydrogen lifecycle - the current methods of production and storage are not viable for making hydrogen an accessible resource.

Jurisdictions around the world are seeking to overcome these issues and uncertainties by promoting financial incentives, seeking investment, and implementing hydrogen hubs. These projects are centred on analysing various stages of the hydrogen value chain (including production, transportation and storage, and final application), identifying issues and their root causes, and creating measures and changes to overcome the limitations.

## R&D IS NEEDED TO OVERCOME THE FOLLOWING ISSUES...



### EXTRACTION

- ▶ H<sub>2</sub> is not found isolated in nature (e.g. water, methane)
- ▶ Current extraction methods are carbon-intensive or costly.



### INSULATION

- ▶ H<sub>2</sub> is lightest element and therefore escapes easily
- ▶ Current gas pipelines and boilers are not suited for hydrogen.



### HANDLING

- ▶ H<sub>2</sub> has low volumetric density
- ▶ Current handling processes for transportation and storage are inefficient as it needs to be compressed or liquified.



### STORAGE

- ▶ H<sub>2</sub> is highly flammable
- ▶ Current safety techniques are challenging to develop as they must be faultless.

# THE CHALLENGES OF HYDROGEN ECONOMY

## FINANCIAL



Significant investment to overcome the technological challenges of hydrogen is required, which is why companies seeking to take on hydrogen are predominantly large, multinational companies who can afford to take on the financial burden. Current hydrogen production costs are high, with green hydrogen costing around \$2.5-\$6.0/kg, and blue hydrogen costing around \$1.5-\$2.8/kg.

Incentives and investment are essential to raise more capital to overcome these technological challenges. Answers to the hydrogen questions may be attained through increasing government grants, ensuring financial incentives are lucrative, and attracting private equity. Decreasing production costs will be realised through continuous innovation in the value, as well as scaling up both renewable technology (such as photovoltaic panels and wind turbines) for green hydrogen and scaling-up the hydrogen production processes themselves.

## POLICY



Favourable policies and incentives are critical for companies and institutions to resolve the challenges of the hydrogen economy, including technological limitations and high costs.

The UK's policy to ban the purchasing and leasing of internal combustion engines cars by 2030 has indirectly supported progress of using hydrogen in the automotive sector. Further policies will be crucial in maintaining and attracting innovators to grow the UK's hydrogen economy.

If you look across the continent, the EU have a policy which states that 50% of grey hydrogen must be replaced by green hydrogen. This move will force the associated technological challenges to be resolved, therefore facilitating much more sustainable production of hydrogen going forward.

## PUBLIC PERCEPTION



Large parts of society still have hesitations over the introduction of hydrogen into our everyday lives. These worries may stem from the Hindenburg disaster, the well-known airship accident in 1937 that killed 36 people after the gasbag, filled with flammable hydrogen gas exploded and collapsed. To this day, when people hear hydrogen and travel in the same sentence, they imagine explosions and loss of life. Hesitation may also come from more recent bad press, such as influential entrepreneur and Tesla CEO Elon Musk criticising hydrogen fuel cells in the media, calling them 'stupid'.

There needs to be a shift in public perception around hydrogen - when society starts accepting the opportunities offered by hydrogen, governments will be more prepared and determined to help solve potential problems to facilitate a sustainable hydrogen eco-system. The initial step is to fully understand the public concerns and address the absence in fundamental hydrogen knowledge by disseminating clear and digestible information.

## PRIVATE EQUITY AND HYDROGEN: HOW WE CAN HELP

With the world of Private Equity increasingly focused on ESG and sustainable investing, the opportunities to invest in the growing hydrogen industry will not be missed. Our team of over 300 Private Equity experts can find the best PE investors and opportunities around the world, and help to secure the backing your business needs to grow.

Our team also has extensive experience of working with PE-backed businesses in the natural resources and renewable energy sectors. We understand the unique pressures and challenges portfolio companies and management teams face. Each specialist can draw on collective experience to help our PE-backed clients get the most out of their business.



Interested in discussing how our Private Equity team can help achieve your ambitions?

[Get in touch today.](#)



# R&D TAX INCENTIVES

## Tax relief for hydrogen production and deployment



### HOW CAN YOUR BUSINESS BENEFIT FROM TAX CREDITS?

As part of its net zero targets, the government has set out its ambitions for 10GW of hydrogen production capacity by 2030. To achieve this, companies are encouraged to invest large sums in research and development covering all issues including production, scalability, supply chain and deployment. This investment can result in activity that qualifies for tax relief. Our R&D specialists can help you identify these opportunities.



### HOW OUR TEAM CAN HELP YOU

Our 100 R&D experts can guide you through the process - we will maximise your chances of a successful claim. We can develop the assessment methodology around your systems and review historical claims to assess if you are under/over claiming. Depending on your circumstances, our team can help you reduce your tax liability or improve your cashflow. [Get in touch now to find out how.](#)

### TAX RELIEF IN A NUTSHELL

1

Worth up to 33% of the qualifying R&D spend, and repayable in cash where the company is loss making. R&D claims must be made within two years from the end of the accounting period.

2

Designed to incentivise companies to undertake innovative and complex development works.

3

R&D claims can be made even when the outcome of a project is unsuccessful.

4

R&D estimates can also help you approach challenging tenders with much more assurance.

# MAIN TAKEAWAYS

1 There is immense potential for the decarbonisation of processes and technologies, which will support the accomplishment of net-zero targets and minimise contribution to global warming.

2 The industry and climate campaigners will be keen that green hydrogen becomes the primary method of hydrogen production. Nevertheless, blue hydrogen will continue to be a necessity for long-term green hydrogen production to become viable. Blue hydrogen will allow scaling-up of hydrogen volumes in the short-term, and drive commercial development of associated infrastructure and technologies.

3 The primary focus for hydrogen technology is on fuel cells for vehicles, and heating of residential and commercial buildings.



4 There are significant challenges hindering the progress of the hydrogen economy, whether they be technological, financial, legislative, or societal, and these challenges need resolving.

5 There are growing opportunities in the hydrogen industry, with increasing investment and government schemes to encourage progress.

6 There are hydrogen strategies in place globally that have started the hydrogen race, but the hydrogen revolution will only become a reality through collaboration between companies, institutions, and countries.



If you would like to speak to one of our Hydrogen experts about how we can support your business, get in touch today.

# OUR SERVICES

BDO's international reach ensures we can provide professional services to sector companies in a way that mirrors their own corporate structures and operations.

Our clients' success is personal to each and every one of the team, so we support our clients through every stage of their development. Our approach is the opposite of one size fits all; it is bespoke, it is client centric and most of all it is delivered by a team who live the sector with you, day in, day out.

On the following pages, we set out some of the services we provide to companies, individuals and governmental bodies working in the Natural Resources & Energy sector. This is not an exhaustive list, but provides an overview of the wide range of skills and expertise that we can provide to your business.

We are happy to discuss your specific needs or services so we can tailor our offering and introduce you to the right people.

## AUDIT



Our deep sector and capital markets insight comes from auditing more FTSE and AIM listed Natural Resources & Energy companies than any other accountancy firm. Our specialist Natural Resources & Energy audit team consists of over 120 partners and staff entirely dedicated to the sector. Our team provide the following types of services:

- ▶ Statutory audit
- ▶ JV audits
- ▶ IFRS conversions
- ▶ Local GAAP conversions
- ▶ Board training
- ▶ Technical training and advisory
- ▶ Agreed upon procedures
- ▶ Corporate governance advisory
- ▶ Regulatory reporting
- ▶ 'Publish what you pay' advisory
- ▶ Integrated reporting advisory.

## TAX



Our dedicated team of Natural Resources tax practitioners combine their wealth of international tax experience with detailed sector knowledge. They work closely with their counterparts across our international offices to deliver a local service with international reach. Our team provide services in the following areas:

- ▶ Tax compliance
- ▶ International tax planning
- ▶ Transfer pricing
- ▶ Intangibles and R&D
- ▶ Tax investigations
- ▶ Global employer tax advice
- ▶ Employee share and incentives
- ▶ EIS/VCT advisory
- ▶ VAT/GST advisory
- ▶ Tax risk and strategy
- ▶ Capital allowances.

# OUR SERVICES

## CORPORATE FINANCE



Around the world, our 2,500 corporate finance experts from 120 countries work together with businesses to maximise their value through advising on acquisitions, fund raisings, flotations and disposals. A typical BDO corporate finance client is either a business with cross-border capabilities or ambitions, or a private equity firm with their niche in the middle market. Partnering our clients for mutual success is what we do and during 2021 we completed 2,022 deals with a total value of USD 128.6 billion.

Our global team are well versed in providing the following services to natural resources industry:

- ▶ Capital markets reporting accountant
- ▶ PLC advisory and Main Market Sponsor
- ▶ Financial modelling
- ▶ Financial due diligence
- ▶ Merger and acquisition advice
- ▶ Transaction support
- ▶ Financial reporting procedure reviews
- ▶ Market research
- ▶ Fairness opinions.

## FORENSIC



BDO's global forensic team have extensive experience of providing forensic services to the Natural Resources sector. BDO's international network has advisory teams in more than 100 countries across the world.

The team regularly provides expert services for international arbitrations, profit sharing, contract dispute and completion accounts cases and can provide expert witness services, valuation and fraud and corruption investigation and prevention services. We ensure a simple and practical approach for our clients by utilising proprietary technology within our work to enhance data mining and eDisclosure, bringing clear insight on issues. Our team provide the following types of services:

- ▶ Expert witness services
- ▶ Quantum determination for international arbitration
- ▶ Commercial dispute resolution
- ▶ Valuations
- ▶ PSA and cost reviews
- ▶ Fraud/corruption investigations
- ▶ Asset investigation and recovery
- ▶ Forensic technology and eDisclosure
- ▶ Anti-corruption and money laundering advice.

## MODEL ASSURANCE



BDO's award winning Financial Model Assurance team is internationally recognised as a market leader with over 20 years of project finance and transactional due diligence experience. We have supported over 2,000 projects worldwide including many oil, gas, LNG, pipeline projects, mining and renewable projects. Our dedicated specialist team use best of breed diagnostic tools and well-developed processes for testing models. This ensures we innovate and create new ways to provide the required assurance on complex financial models.

Through working collaboratively across BDO International we can support projects worldwide. Our team provide the following types of services:

- ▶ Bid and Financial Close Model audit and review
- ▶ Modelling best practice reviews
- ▶ Integrity and comfort reviews
- ▶ Operational model review and covenant monitoring
- ▶ Model development and updates
- ▶ Fund/Secondary market acquisition model due diligence.



# OUR SERVICES

## GLOBAL OUTSOURCING



When your business is global, your financial operations pose a twofold challenge. On the one hand, you want to streamline and centralise the finance function and on the other hand, you must ensure that your international subsidiaries comply with diverse national reporting regulations. Our global outsourcing specialists can take away the compliance and operational burden of managing and maintaining multi-jurisdictional books, records and filings.

The team provide the following types of services in all of BDO's 160+ jurisdictions and many other challenging, developing economies which are often rich in Natural Resource opportunities.

We make complex operations as simple as possible working under a single, global agreement using sophisticated technology, such as Thomson Reuters Workflow Manager, to give you visibility and control of:

- ▶ Global compliance and reporting, including direct and indirect tax
- ▶ Global payroll
- ▶ Financial statement preparation in IFRS and local GAAP
- ▶ Company secretarial and regulatory compliance
- ▶ Back office finance function services.

## INTERNAL AUDIT



Internal Audit has always been one of the cornerstones of good corporate governance. However, increased regulation, greater public scrutiny and increased globalization have seen the importance of an effective internal audit function enhanced at Board, Audit Committee and Executive level.

For large and small businesses alike, we design and deliver appropriate internal audit functions - from conducting a thorough assessment of risk across the organisation, to designing strategic internal audit programmes, to reporting findings to management, the board, and other stakeholders. We not only identify issues, but we work with management to implement tailored solutions and put the appropriate controls in place. Our team provides the following types of services:

- ▶ Full outsourcing of internal audit
- ▶ Co-sourced and partnership internal audit services
- ▶ Quality assurance reviews for, and training of, internal audit functions
- ▶ Process and internal controls consulting
- ▶ Continuous auditing monitoring
- ▶ Board and Audit Committee advice and training
- ▶ Contract and joint venture audits.

## TECHNOLOGY ADVISORY



BDO IT Solutions offers a breadth of expertise, innovative thinking and valuable insight with a core focus on business processes and sustainable effectiveness. Specialising in servicing the Natural Resources industry, BDO's IT Solutions business drives productivity solutions around ERP systems. Services provided include:

- ▶ Content Management & collaboration
- ▶ Cyber-security
- ▶ Enterprise portals and scalability
- ▶ UX, CX
- ▶ Smart meter integration & analytics
- ▶ Office 365 migration & 3rd Party access
- ▶ Records Management & regulatory compliance
- ▶ CRM development
- ▶ Modernisation & cloud development
- ▶ Managed services.

# CONTACTS



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Marc has over 25 years of experience in working with companies in the energy sector. He started his career with PwC in Germany and joined BDO UK in 2003 and he now heads up the Renewable sector for BDO International.

As an audit partner he has audited companies across a wide spectrum of technologies and works with large listed international Groups as well as private equity backed companies.



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David is a partner in the London Transaction Services team with broad experience across all sectors and deal sizes. David is focussed on transactions in the environmental sector and leads BDO's TS renewables practice.

David also supports a number of large corporates on transaction work including BP, dnata, Smiths Group and BT and has extensive cross border M&A experience.



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Steven leads our Innovation & Technology Group across the UK and co-leads the BDO Global R&D team. He is a tax partner at BDO and has specialised in R&D tax claims since their inception in 2000. He has worked in all industry sectors including oil and gas, energy, manufacturing and engineering, defence, marine, energy, and software development. Steven leads BDO's R&D services in the UK covering our Net Zero, energy, renewables, and sustainability clients.

Steven has been a member of the HMRC R&D Communications Forum (formerly R&D Consultative Committee) for around 16 years and has worked closely with the Revenue to ensure that BDO are at the forefront on HMRC changes in legislation and interpretations.



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Gareth is a Partner in BDO's Advisory team and advises international, growth orientated companies from a number of sectors including Natural Resources and Renewables, where he sits on the firm's Natural Resources and Renewables sector Groups.

Gareth is passionate about helping his clients realise the benefits of utilising the latest accounting technologies, which are the focal point for the suite of business support solutions that he and his team are able to offer. These encompass a broad range of business advisory, accounting, outsourcing and compliance services that are tailored to a client's specific needs and requirements.

## FOR MORE INFORMATION:

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