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Maximising COP26 and the pathways to net zero

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Harvard Kennedy School

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PUBLIC POLICY PROJECTS

Maximising COP26 and the pathways to net zero

Foreword

FOREWORD BY THE RT HON AMBER RUDD AND THE RT HON CLAIRE O'NEILL

It has been a great pleasure for us to work with new colleagues at PPP to develop policy solutions to some of the energy challenges the world is facing in its journey to net zero.

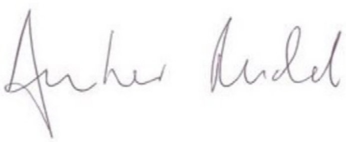
In order to deliver something new and we think, relevant, we decided to examine particular energy sources through the prism of individual countries.

We did this to reveal the way different renewables and polices are working for individual countries. We hope that governments can learn from each other. The enthusiastic attendance of so many High Commissioners and Ambassadors at our webinars suggests that there is enthusiasm to learn from each other.

Different countries may have very different energy mixes, both because of their individual geography and because of their different culture, but they still want to benefit from each other's experiences. Such is the scale of the challenge ahead that we need an "open source" attempt to finding solutions. We've set some out in our document here, holding up a mirror to the different approaches being run in different countries. We're particularly grateful to the High Commissions of Australia, and Namibia and the Embassy of France for kindly sharing so much information and expertise with us and with the public.

It has been a fascinating exercise, brilliantly written up by our former colleague The Rt Hon Chris Skidmore MP, now Director of Policy at Public Policy Projects, and Max Austin, Eliot Gillings, Will Farrell and Adam Kerson.

We hope you find it as interesting to read as we did to work on and prepare.



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Chris Skidmore is Director of Policy for Public Policy Projects and Member of Parliament for Kingswood. He was the UK's Minister for Universities, Science, Research and Innovation between 2018-2020 and the UK Energy and Climate Change Minister in 2019. In this role, he helped secure COP26 for the UK and signed the UK commitment to reach net zero carbon dioxide emissions into law in June 2019. He is currently a Senior Fellow at the Mossavar-Rahmani Center for Business and Government at the Harvard Kennedy School and an Honorary Fellow of Birkbeck College, University of London.

Recommendations

MAXIMISING COP26 AND THE PATHWAYS TO NET ZERO

- International investors and the wider private sector should continue to seek opportunities to enable middling and emerging economies to transition as energy producers and decarbonise.
- National Low Emissions Technology Strategies and National Hydrogen Strategies should be developed by every nation. Goals for the deployment of key enabling technologies should be included to set out a clear pathway towards action and to encourage future inward investment.
- Identify, and invest in, those industries where hydrogen can be most immediately effective in order to secure the greatest outcomes in emission reductions. Hydrogen must not be placed in competition with other renewable energy generation but should instead be viewed as a compliment to existing technologies, and ought to add to investment in the expansion of renewable infrastructures.
- Heavy goods shipping, long-haul maritime shipping and heavy industrial manufacture are some industries that would most benefit from the deployment of Hydrogen as a power source. 75% of primary energy usage lies outside the power sector and, as such, it is in these industries where hydrogen can play its most important role.
- Choices must be made with regard to the value of hydrogen in the energy transition. Focusing on the wider immediate deployment of hydrogen across all sectors is unnecessary. Instead, there should be an emphasis on looking at the capacity and capability of technology and making appropriate choices accordingly.
- An international agreement must be created to address the adoption, and trading, of hydrogen. This agreement will need to address the creation of the necessary infrastructure to harness hydrogen's potential.
- Incentivising demand for clean hydrogen must be a central question for policy makers.
- There must be some form of international acceptance and agreement that all countries should prioritise the cleanest, or green, forms of hydrogen in markets that should value low carbon intensity hydrogen.
- The first priority for international agreement on hydrogen should be to prioritise the decarbonisation of the entire supply of hydrogen. This will require establishing a clear taxonomy and set of regulations concerning hydrogen supply and use.
- A new and accurate internationally agreed measurement for hydrogen (based not upon mode of production, but intensity of carbon emissions generated in production) is needed.
- New hydrogen standards should be adopted internationally and be based on the full life cycle of carbon. This will engender more accurate and fair hydrogen pricing.
- International safety and technical standards must be established. This should include standards for quality and interoperability in hydrogen production as well as transport, storage distribution, and end use.
- Once these standards have been agreed, a new regulatory body (or bodies) will be required to provide assurance of the framework, encouraging public acceptance and confidence in a safe hydrogen market.
- Adopting the latest AER model, Nuclear for Hydrogen should be a strong focus for future policy makers, and a feature of discussion at COP26.
- COP26 should open its eyes to the combined value of nuclear and hydrogen as a complementary strategy alongside renewable energy.

Chapter One

THE OPPORTUNITY TO MAXIMISE COP26

COP26 provides both the opportunity and the challenge of delivering an international agreement on climate change. The agreement reached at Paris in 2015, the last time that an ambition COP was held, has been viewed as the model and standard by which success or failure at Glasgow should be judged.

This is a mistake – and sets a dangerous precedent for placing an over-reliance on process to deliver emissions reductions. Every COP, every single year, now matters, as the international community moves towards an agreement on reducing carbon emissions. What counts is not only commitments for the future, but investments and outcomes delivered in the present.

Within that present, we must recognise the significant progress that has been achieved in recent years. Since the UK became the first G7 country to sign Net Zero into law, we have seen the US, France, Korea, and China, among over a hundred countries representing two thirds of the earth's land surface, commit to a net zero target. A delegate attending Paris would be amazed at this level of progress.

There has also been significant advancement in the commitment to end the use of coal power, both from nations setting out their phase out of coal, and the international finance community seeking to limit investment in coal. Alok Sharma has used his time as COP President Designate to great effect, securing revised and more ambitious NDCs from countries, with the UK committing to reduce emissions by 78% by 2030. COP26 will provide further opportunity for the final submission of NDCs and international agreement on emissions reductions.

Yet it is equally important to recognise that, despite what is or what is not agreed at COP26, the international gathering of nations provides an opportunity to shape future dialogue, and to shift the narrative to areas of policy, and nations seeking to make their own energy transitions that deserve greater focus.

The purpose of this policy paper, Maximising COP26, is to aid that opportunity: by providing insight from several countries whose own energy transitions are underway, and from whom the wider international community can learn important lessons.

It is the result of a series of webinars and roundtables that have been hosted by Public Policy Projects in 2021. These events, a full list of which and links to view appears in the Appendix, were organised to present both a series of countries and the application of future technologies and innovation within them, from which wider adoption could occur. These include:

- Plans for the generation of hydrogen in Namibia through renewable electricity sources that include solar and wind power.
- The future role of hydrogen production in Saudi Arabia
- The use of low-emissions technology and hydrogen in Australia

The theme that runs throughout this report is that, just as we must prioritise outcomes today over commitments tomorrow, we should not engage in the fiction of creating good versus bad actors on the climate policy stage. There are no winners if we seek to divide or to exclude those voices who are considered high emitters of emissions.

The commitment to Net Zero by many countries across the world is highly encouraging. Yet we must now ensure that commitments become certainties; and with certainty comes the need for detailed plans setting out the plans for the transition away from carbon. There is no one size fits all approach. Each country must prepare a pathway that is both realistic and works for its entire population. The purpose of this report is to highlight specific case studies and examples of where approaches may differ, yet they do so because they are complementary to the individual needs and requirements of a country. It is these individual needs and requirements that this report aims to highlight, and in turn demonstrating the need for an inclusive approach that takes every nation and every community with us on the path to Net Zero.

Chapter Two

CASE STUDIES AND APPROACHES

In preparation for this report, Public Policy Projects have held a series of webinars as part of its World Economic Series that have focused in detail on how several countries have developed their future national strategies for decarbonising their economies. These countries include Australia, Namibia and Saudi Arabia, each of whom have chosen separate yet complimentary approaches to delivering a low carbon future, by investing in low emissions technologies and the future of hydrogen production.

2.1 Australia

Australia is the world's largest exporter of coal and has an estimated 46% of the world's uranium resources, 6% of coal resources and 2% of the world's natural gas resources.[1] Much of Australia's exports are directly used for generating electricity overseas and Australia exports over three times as much black coal than it uses nationally.[2] This has led to Australia having a smaller emission reduction rate than the US, Japan, the UK and the EU, despite being a fraction of the population. All types of coal included accounts for more than half of the countries' energy exports while also being a major exporter of Uranium. Nuclear power is banned in Australia, so the country strongly relies on heavy-emitting fossil fuels and is one of the heaviest polluters in the entire OECD.[3]

Australia has settled on a low emissions strategy of investing, developing, and finally deploying low-emission infrastructure technology. These developing industries will be both owned and managed by a mix of public and private enterprises, much like how the current Australian energy sector is designed. This innovative method has resulted in large financial pledges such as an A$1.2 billion which will seek to develop up to seven clean hydrogen industrial hubs nationwide.

The Australian Federal Government has announced a whole-of-economy Long-Term Emissions Reduction Plan aimed at reducing Australian emissions and achieving net zero by 2050.[4] 'The Plan' as it is commonly referred to, does not rely on the levying of additional taxes, increased costs on households nor result in the loss of Australian jobs. This is because the plan is centred around developing and then deploying low emission technologies and setting Australia as a major exporter of resources like hydrogen and ammonia.

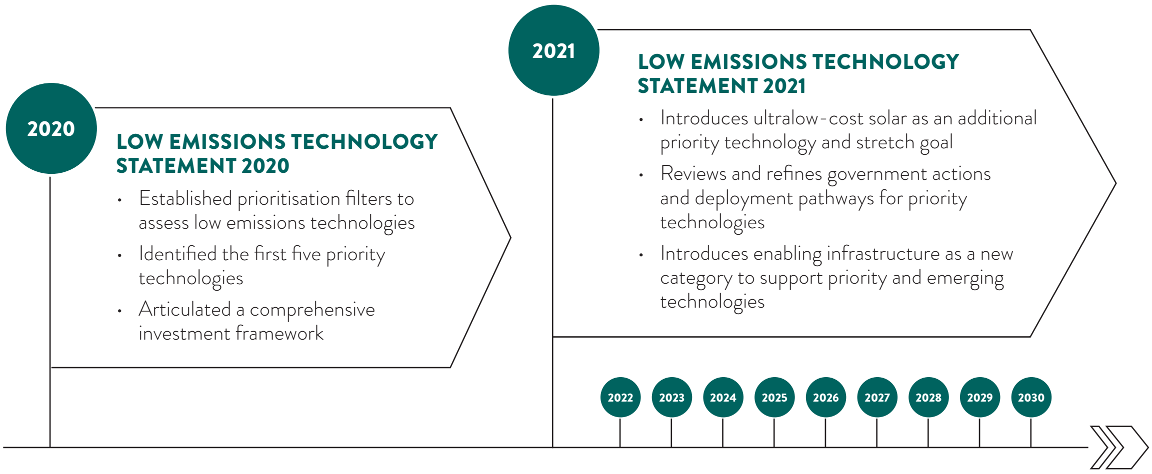
Alongside the Long-Term Emissions Reduction Plan, Australia has produced a Technology Investment Roadmap that sets a process to develop and deploy low emissions technologies. By focusing government investment, it aims to make these technologies cost about the same as existing high emission technologies.[5]

The government has established an investment criteria for these low emissions technologies, which sets the framework and process for future strategic decisions and investment in low emissions technologies:

1. Survey new and emerging low emissions technologies.
2. Identify priority low emissions technologies. These are technologies:
    - with the biggest economic and emissions impacts
    - where Australia has economic, natural, technology or skills advantages
    - where government can make a difference.
3. Set an economic stretch goal for each priority technology. These are ambitious, but realistic, cost targets that will help the technology cost about the same as existing high emissions technologies.
4. Identify pathways to meet stretch goals.
5. Invest in priority technologies to help them reach their stretch goals.
6. Measure how existing government investments are making a difference, and fine-tune these investments over time.

TECHNOLOGY INVESTMENT ROADMAP

An enduring process for low emissions technology investments. Annual low emissions technology statements review, refine and evaluate investments. The roadmap is the cornerstone of Australia's Long-Term Emissions Reduction Plan.



Accompanying this, the government has committed to publishing annual Low Emissions Technology statements (LETS). Each statement reviews and refines the government's technology priorities and goals, reports on our progress towards these goals and in turn fine-tunes the government's investment approach for the biggest economic and emissions reduction outcomes.

The first Low Emissions Technology Statement, released in 2020 (LETS 2020), identified five priority technologies and set economic stretch goals for each one:

- clean hydrogen – production under $2 per kilogram
- energy storage – electricity from storage for firming under $100 per megawatt hour (MWh)
- low emissions materials (steel and aluminium) – low emissions steel production under $700 per tonne and low emissions aluminium production under $2,200 per tonne[1]
- carbon capture and storage (CCS) – carbon dioxide (CO_2) compression, hub transport and storage under $20 per tonne of CO_2
- soil carbon – soil carbon measurement under $3 per hectare per year.

Economic stretch goals are ambitious but realistic goals to bring priority low emissions technologies to cost parity with existing high emissions technologies.

The second LET was published at COP26 on 2 November, adding ultra low-cost solar electricity generation as another priority technology, with an economic stretch goal for solar electricity generation at $15 per MWh, or approximately a third of today's costs.[6] LET2021 also set out key priority technologies, with not only commitments assigned to each technology, but an impact evaluation framework to be published annually- a reporting mechanism to chart progress against measured benchmarks.

2.2 Australia's Hydrogen Strategy

While Australia will not be building any nuclear power plant stations in the relative future unless there is a drastic political change in Canberra, the federal government has been encouraging companies to investigate setting up Australia as the world's leader in low-carbon energy source exports. Recently, Australia published their own National Hydrogen Strategy, setting out ambitious plans for future inward investment in hydrogen.

PRIORITY TECHNOLOGIES AND THEIR ECONOMIC STRETCH GOALS

ENERGY STORAGE
Electricity from storage for firming under $100 per MWh

ULTRA LOW COST SOLAR
Solar electricity generation at $15 per MWh

CLEAN HYDROGEN
Production under $2 per kilogram

SOIL CARBON
Measurement under $3 per hectare per year

CARBON CAPTURE & STORAGE
CO_2 compression, hub transport and storage under $20 per tonne of CO_2

LOW EMISSIONS MATERIALS
Low emissions steel production under $700 per tonne and low emissions aluminium production under $2,200 per tonne

The Low Emissions Technology Statement published in November 2021 set out plans for continuing work on a National Hydrogen Infrastructure Assessment. Building on this, a complementary assessment of infrastructure needs for other priority technologies will be conducted. This will include exploring ways to reduce costs by locating hydrogen, energy storage, and CCS infrastructure near manufacturers such as steel and aluminium companies.

Government commitments have been enhanced by further private investment, including a feasibility study launched by BP in August 2021 into developing a 1 million tonnes per annum green hydrogen and green ammonia production facility.[7] This facility would be constructed in Western Australia and be equipped with its own electrolyser while being completely powered by renewable energies such as wind and solar power. BP's study, backed by ARENA, found that production of green hydrogen and green ammonia is feasible at export-scale and could make Western Australia a major international supplier of green hydrogen and green ammonia.

Further, in August 2021, Australia's Origin Energy and Japan's Mitsui OSK Lines announced they would jointly study whether Australia's green ammonia projects could supply Asian and other international markets from 2026. Concurrently Origin Energy is also conducting a feasibility study worth A$3.2 million into developing green ammonia in Bell Bay, Tasmania. Mitsui has also announced the construction of two large carriers to transport both LNG and ammonia. The vessels will be able to be powered by either energy source and are expected to primarily operate between Australia and Japanese and South Korean markets.[8] Origin also announced a memorandum of understanding with the Australian port of Townsville in Queensland to expand the port to accommodate for green hydrogen export. This memorandum of understanding will be applied to both Origin and its partner in the venture, Kawasaki Heavy Industries. Currently, plans include constructing a new berth and the developing a facility capable of producing 36,500 tonnes of green liquid hydrogen per annum and to be operational by the mid-2020s.[9]

At the same time, the plans to build the world's largest green hydrogen and ammonia plant are currently undergoing environmental impact reviews, with significant changes expected to be applied to current plans. The project is referred to as the Asian Renewable Energy Hub and would be based in Western Australia.[10] The plans included a facility with the ability to produce 1.8 million mega tonnes per annum of green hydrogen and 10 million mega tonnes per annum of green ammonia, to be exported to Japanese and South Korean markets. The facility itself would be powered by a 26GW wind and solar farm, which is the part of the plan which is currently under environmental impact review. The project is being backed and developed by InterContinental Energy and its partners - CWP Global, Pathway Investments (Macquarie) and wind turbine producer Vestas. Once the plan makes the necessary changes and receives environmental impact approval, the target date for financial close is 2025 with first production and exports from the facility beginning as early as 2027.

2.3 Australian Financing and Investment in Hydrogen and Low Emissions Technology

Australian Federal Government has allocated an A$18 billion to be invested over the next ten years on a range of technologies to cut emissions.[11] Of this, A$1.4 billion will be allocated to the Australian Renewable Energy Agency (ARENA), with a specific A$75 million to be allocated to low emission technologies like Electric Vehicle charging stations.[12] Additionally, Australia's 'green bank' is currently investing A$10 billion into low emission technology.

The grants specifically for hydrogen projects add to A$1.2 billion the government has allocated towards investing in hydrogen, including low-cost financing, aiming to drive down the cost of hydrogen production to less than A$2 per kg. According to Federal Australian Government modelling, The Plan will increase the national income per capita by almost A$2000 by 2050, when compared to a 'no policy change' scenario.

In May 2021, the Australian Renewable Energy Agency awarded an A$42.5 million grant to a joint venture by the French firm Engie SA and Norway's Yara International SA towards building a renewable hydrogen plant to produce green ammonia.[13] The production plant is currently planned to be completed in 2023 and will house a 10 megawatt electrolyser, becoming one of the world's first industrial-scale renewable hydrogen production operation. To be built in the soon-to-be hydrogen capital of Western Australia, the facility will also be dedicated towards providing low-emission energy for the large Asian markets of Japan, South Korea and potentially the nation of Taiwan. In September 2021, The Australian Federal Government announced an additional AUS$150 million, adding to the current AUS$464 million Federal fund for feasibility studies and the construction of hydrogen projects in seven clean hydrogen industrial hubs to concentrate demand for hydrogen in one geographic region to reduce costs and share information. These hubs will bring hydrogen producers, users and exporters together. They will lower the cost of production, encourage innovation and enhance skills and training efforts.

Carbon Capture and Storage

Overall, the Australian government has earmarked A$300 million for carbon capture and storage technologies over the next 10 years, with A$250million being directly dedicated to helping fund technologies for the research and development of carbon capture technology.8 The remainder A$50 million has been allocated to projects which look to being developing carbon capture and storage sites around Australia the six individual projects mentioned above such as the Moomba CCS project. In June 2021, the Australian government financially backed six carbon capture projects worth a total of A$50 million ($37 million). These investments look to add up to 470 jobs and eventually deliver A$412 million in private investment to the sector overall.

The projects that received funding included Australia's second largest energy provider Santos Ltd, which recently joined Beach Energy to invest A$220 million ($165 million) on carbon capture and storage technology in Moomba, received A$15 million towards the Moomba CCS project. This project will see the storage of over 1.7 million tonnes of CO2 a year, using the depleted oil fields in the cooper Basin of South Australia. Another project that received funding was Glencore PLC, which received A$5 million for their A$120 million CTSCo project which plans to capture the emissions from a coal-fired power plant and store it under Surat Basin in Queensland. A$14.6 million was invested into the Mineral Carbonation International demonstration plant designed to capture emissions from facilities that produce construction materials such as concrete, plasterboard and fire-retardant materials. The demonstration plant will be on Kooragang Island in New South Wales.

Up to A$9 million of funding was allocated to Energy Developments for the capture of emissions from the production of biomethane at landfill sites across multiple locations and areas throughout Australia. This carbon capture method would be key in then producing cement carbonation curing. At the same time, A$4 million was allocated to the Corporate Carbon Advisory Pty for the viability of direct-air-capture and storage capabilities from a current in-use well in Moomba, South Australia. And finally, A$2.4 million was allocated to Boral Ltd, for a pilot scheme to scale carbon capture and use technologies to improve the quality of recycled concrete, masonry and steel slag aggregates.

AUSTRALIA CASE STUDY

While net-zero has remained a hot topic in recent years, there is a need to shift the focus of the ongoing conversation away from planning and towards action. Australia has recently released its net zero strategy just in time for COP26, which heavily emphasises investment into carbon capture technologies, the continued deployment of carbon credits (ACCUs) and a target deadline to reach net zero by 2050.

Through focusing on delivering reliable and progressively cheaper renewables by investing in the expansion and connection of its wind and solar plants, in addition to investing A$200 million over ten years into carbon capture technologies and developments, Australia has driven down the cost of the transition to competitive green steel, green aluminium, and overall industry decarbonisation. Essential to this success has been the use of clear policy drivers and legal frameworks, as well as clear communication between the private and public sectors. Crucially, the Australian government has stated that its transition will not cost any jobs nor require additional taxes to pay for their energy transition.

There is no better proof of this than the Tomago aluminium smelter's announcement of its intention to switch to 100 per cent renewable electricity by 2029. Australia's largest energy consumer, the Tomago smelter also contributes £820 million to the Australian economy annually, signifying the scale of Australia's progress with regards to cheapening the cost of renewables.

Generating investment will be key, and through setting clear and ambitious strategies Australian policymakers are currently succeeding in doing so. According to a report published earlier this year by MinterEllison and Acuris, 65 per cent of investors say they will increase investment in renewables within the next 12 to 24 months, making Australia one of the most supportive financing environments for renewables.

However, while significant progress has been made throughout the country since South Australia fortified its renewable infrastructure in 2016, there are still obstacles to be overcome before Tomago will be able to act on its intentions. The cost of firm renewable energy is still too high (currently around $70 per megawatt-hour) to enable a complete transition to renewables at the current time. Policymakers will, as such, need to continue to work with industry to grow the capacity and reliability of their networks to best utilise existing technology. Simultaneously, there is also a pressing need for investment in the development of new technologies, particularly the creation of commercially viable energy storage.

- The Australian Energy Market Operator (AEMO) is prepared for periods of 100 per cent instantaneous solar and wind electricity by 2025 across the whole of the national electricity grid.
- Australia is committed to delivering 24/7 clean electricity that will be competitive with the current price of coal-fired electricity by 2029.

2.4 Namibia

Namibia has a population of around 2.6 million, roughly the same size as the city of Chicago in the United States. However, with a land area of around 317,874 square miles, the south-east African nation has large ambitions, and the framework is set for the country to punch far above its weight in the fight for global net zero.

The realities of climate change are very apparent to the nation of Namibia, as the country is in a geographically disadvantageous position to be dealing with rising sea levels and increasing droughts. With an economy that is highly reliant on its agricultural sector and imports a significant amount of its energy from coal-powered energy plants in South Africa, Namibia is a nation that will greatly suffer should the climate continue to deteriorate.

Currently, Namibia is reliant on hydroelectric power, which is currently providing two-thirds of the nation’s domestic installed power capacity.[14] Overall, however, energy directly from renewables accounts for 30.3% of the nation’s Total Final Energy Consumption (TFEC) as so 2018. Also, with only 54.0% of its population having regular access to electricity as of 2018 according to the International Renewable Agency, the nation’s energy needs will continue to increase as both access to energy and its population increases.

2.5 The Harambee Prosperity Plan and Hydrogen Investment

In response to this reality, the Namibian government in March 2021 launched the Second Harambee Prosperity Plan (HPPII) aimed at economic growth and pandemic recovery while simultaneously encouraging feasibility studies into hydrogen development. This plan was designed along a “five pillars” approach of:

- effective governance
- economic advancement
- social progression
- infrastructure development
- international relations & cooperation.

At the forefront of this plan is the development of hydrogen power and the encouragement of foreign investment into this potentially world-leading sector.

Government and international plans in Namibia include developing the southernmost region of the nation into a solar power hub, using this power to develop hydrogen energy to ship to nations like South Africa, Botswana, and other African nations.[15] According analysis conducted by the Namibian government, the nation has the potential to capture around 10 hours of strong sunlight per day for nearly 300 days out of the year, which would make the nation one of the best countries to invest solar power into due to its high solar irradiance potential. Additionally, recently in the last couple years, Namibia announced plans to build four more wind power plants to increase its current wind energy generation from the current 4 gigawatts it currently produces to nearly 100 gigawatts.[16]

The industry's development within Namibia is currently largely focused on the creation of electrolysers that can harness Namibia's wind speeds of more than eight metres per second (with capacity factors north of 50 percent) and solar potential, which boast a 30 percent capacity factor using a rotating solar panel. In order to secure the funding to establish the necessary infrastructure Namibia has, in the words of James Mynupe, "put in place an extremely transparent system" that sets clear but ambitious targets – including the target of generating capacities of 5 to 7 gigawatts, "10 times [Namibia's] own electricity consumption at peak." The plan has "attracted over 15 bidders who have bought the bid document," while the United States State Department, through its USAID wing, has signed a Memorandum of Intent in April 2021 to develop solar power.[17]

These potential investments will put Namibia in a very advantageous position where it will not only be able to be completely net zero but also provide renewable energy to its neighbours and even international markets. Currently one of the largest barriers to developing hydrogen production has been the price of running the necessary electrolyser with solely renewable and nuclear power, which makes the price uncompetitive to hydrogen produced by coal or even fossil fuels. However, with the estimated 3,500 hours of sunlight and thus solar power those 300 days in southern Namibia could provide, the price of hydrogen could be dramatically reduced to a highly competitive €1.50-2.00 per kg ($1.76-2.34). This price would be cheaper than anything other national competitors could reasonably provide, which would allow Namibia to potentially become a world leading hydrogen production and export capital.

Due to this potential possibility the German government recently announced plans to import hydrogen sourced in Namibia, with German science minister Anja Karliczek and Namibian Planning Commission head Obeth Kandjoze signing a joint communique of intent to develop the southern region of Namibia into a hydrogen process area.[18] With this political commitment, the German government has also announced plants to provide up to €40m in investment for the partnership. According to estimates by the German government, Germany would need around 90 to 110 TWh of hydrogen per year by 2030 which would only increase as more sectors of the country become decarbonised and remove coal and other fossil fuels from their energy sources.[19]

2.6 Challenges faced by Namibia for Hydrogen Production

One of the issues facing Namibia is the geographical reality that it is very dry, one of the driest nations on the African continent. To fully benefit from its sunlight and hydrogen producing possibilities, the nation will need to deploy desalinisation plants to turn their largest body of water, the Atlantic Ocean, into a source of water for the electrolysers. This reality was highlighted in the Nation's 2021 Updated Nationally Determined Contribution where the need to prioritize seawater desalinisation was highlighted and estimated to cost USD$78.6 million between 2020 and 2030.[20] Additionally, Namibia is not currently developing domestic desalinisation methods, so these technologies will need to be imported once they become economically viable in their process. To this end, the German government has announced a feasibility study of the potential of a green hydrogen economy in Namibia exporting hydrogen energy to Germany which will include innovative desalinisation technologies.

Despite this, the Namibian government is making great headways into laying the appropriate groundwork to develop Namibia into a hydrogen exporting capital. A part of this has been the creation of the Namibia Government's Green Hydrogen Council, an entity designed to make investment as efficient as possible while ensuring the transparency of funding for hydrogen power in Namibia.[21] The development of hydrogen power in Namibia provides the nation with a brilliant opportunity to decarbonize its economy, expand its industrial sector, bolster its employment rates and reduce its current reliance on agricultural exports which often lead to environmental degradation and wildlife habitat loss.

NAMIBIA CASE STUDY

Sunny, sparsely populated, and windy, Namibia possesses a rare combination of natural resources that makes them a prime candidate to produce green hydrogen. By implementing an ambitious and though hydrogen plan, Namibia has positioned itself to grow its hydrogen economy rapidly – and deliver on its targets of becoming the first decarbonised nation in Africa and reducing greenhouse gas emissions by 92 per cent by 2030.

Namibia's growth as a hydrogen producer forms a key part of its government's broader economic recovery plan. The Harambee Prosperity Plan II (made up of five pillars, effective governance, economic advancement, social progression, infrastructure development, and international relations and cooperation) places Namibia's hydrogen strategy as one of the three primary goals within the economic advancement pillar.

Hydrogen's development, as such, is contained within a framework that integrates Namibia's ambitions for the industry with the development of other sectors and its desire to optimise its stewardship of natural resources. This envisioned expansion of the industry also aims to expand opportunities for training and high-skilled employment. As well as growing industry within Namibia, the Harambee Prosperity Plan II aims to use hydrogen to decrease unemployment (from 35 to 5 per cent), reduce the Gini-coefficient (from 0.7 to 0.3 per cent), and ease the rural sector's integration into the modern economy.

Namibia's hydrogen industry is currently focused on the creation of electrolysers that can harness Namibia's wind speeds of more than eight metres per second (with capacity factors north of 50 per cent) and solar potential (which boast a 30 per cent capacity factor using a rotating solar panel. Included in these targets is the goal of generating capacities of 5 to 7 gigawatts (more than 10 times Namibia's current energy usage) and the aim of pricing green hydrogen produced via electrolysis as low as £1.30 per kg.

While some of that increase will cover the usage of a significantly more active Namibian economy, most of that increased generation capacity is intended for export with Namibia intending to play a major role in the commercialisation of hydrogen at a global scale.

- Namibia has secured an agreement with the German government that will see £35 million deployed to aid in the development of green hydrogen infrastructure.
- Namibia's wind speeds of more than eight metres per second (with capacity factors north of 50 per cent) and solar potential (30 per cent capacity factor using a rotating solar panel) both globally rank amongst the most promising places to develop green energy infrastructure.

2.7 Saudi Arabia

The Kingdom of Saudi Arabia is one of the world's biggest oil exporters, having greatly benefitted historically from exporting crude oil all around the world. Yet recently Crown Prince Mohammed bin Salman has announced that the Kingdom will be cutting its carbon emissions to net zero by 2060.[22] This announcement came as a part of the Saudi Green Initiative and would require the Kingdom of Saudi Arabia to cut its carbon emissions by over 270 million tonnes per year. The Saudi Green Initiative is the net zero and decarbonisation effort by the Kingdom of Saudi Arabia and the Crown Prince has pledged to invest more than £130 billion to reach the goal of net zero by 2060.

The pledge is based on five priority areas which include:

- reducing carbon emissions
- protecting the oceans
- defending wildlife
- preventing the continued desertification
- increasing recycling.[23]

The Saudi Green Initiative will oversee all of Saudi Arabia's work in combatting climate change, while also working to bring together government ministers, private sector entities and foreign leaders for the cause of preventing climate change.

This pledge does not preclude Saudi Arabia from continuing to produce oil for the next few decades to come. It does however pledge to reduce methane emissions, joining the US in attempting to curb methane emissions by 30% before 2030.

2.8 Countering Economic Change with Investment in New Low Emissions Technologies

It is a reality that petrostates, especially in the Gulf region, will suffer economically if they make no significant changes to their export commodities, due to international emission-reduction targets.[24] While Saudi Arabia would be one of the worse nations to be affected, Bloomberg has projected that petrostates in general will lose up to $13 trillion by 2040 due to this change.

Analysis like this has clearly not gone unnoticed in the Kingdom of Saudi Arabia, and the Crown Prince has been quick to announce that Saudi Arabia would use innovative technology to create a 'carbon circular economy' using Carbon Capture and Storage (CCUS) technologies.[25] In conjunction with this report, state-backed Saudi Aramco announced that it would take responsibility for carbon emissions during the entire production of its oil, also known as scope 1 & 2 emissions.[26]

Recently in a forum in Riyadh Crown Prince Mohammed bin Salman announced that the Kingdom would also establish an investment fund for Carbon Capture technologies, stating that, "Climate change is an economic opportunity for individuals and the private sector...[that reducing emissions will] create jobs and strengthen innovation in the region."[27]

We agree with this sentiment, assisting emerging innovative technologies while also establishing a comprehensive multi-pronged attack on global emissions is the key in our journey towards net zero. In addition to this investment fund, the Crown Prince announced that it would back a plan to feed hundreds of millions of people by providing them clean cooking fuels. Together the two initiatives will cost a total of $10.4 billion, with Saudi Arabia committing to providing 15% initially.[28]

One of the carbon capture methods the Kingdom of Saudi Arabia investigated is freezing greenhouse-gas emissions from power plants.[29] This process w0uld require a technique to cool the carbon dioxide when the fossil fuels are combusted to produce electricity. This theory, currently being tested by the King Abdullah University of Science and Technology with cryogenic technology from the US-based company Sustainable Energy Solutions. The idea has been piloted to capture around 1 ton of carbon dioxide in a day from a single emission source, with scientist involved in the project hoping to capture up to 25 tonnes of carbon emissions a day from the source within the next two years. Overall the project will cost around $25 million and if successful in the pilot and testing phase, the technology could be adapted to be able to capture up to 1,000 tons of carbon emissions per day.

2.9 Saudi Arabia's Hydrogen Strategy

While developing and promoting carbon capture technologies, Saudi Arabia has also been developing the $5 billion Helios Green Fuels Project in the country. Scheduled to be operational as soon as 2025, this site has already attracted €1.5 million from Germany late last year[30], and will be capable of producing 650 tonnes of hydrogen and 3,000 tonnes of ammonia per day. This production would equal around 15,000 barrels of oil per day, which will be significant if Saudi Arabia can corner the hydrogen market as the world shifts away from fossil fuels in preparation of 2050.[31] The facility and electrolyser used in this project would be powered by 4 gigawatts of renewable energy sourced from wind, solar and carbon capture technologies.

Interestingly, this site would focus on producing ammonia for export, which would then be used as fuel to produce hydrogen in the target nation, for use as an alternative fuel in transportation. The site has already received investment from Germany, the Danish chemical catalysis producer Haldor Topse and the US-based Air Products & Chemicals. The facility is expected to be located in Neom, the $500 billion Giga and smart city project currently being built in the north-west of the country near the Red Sea and Gulf of Tiran.

Much like the case with Namibian hydrogen production, due to the geographical factors at play in Saudi Arabia, hydrogen production at the Helios plant is projected to potentially be as low as $1.50 per kg, which would be among the lowest in the world and cheaper than hydrogen made from non-renewable sources today.[32]

2.10 Global Aspirations and Ambitions

The three cases studies above— Australia, Namibia and Saudi Arabia— demonstrate the important and innovative efforts that these countries, two of which feature high-carbon intensity economies due to the historic nature of their industrial baselines being established in fossil fuels, are seeking to establish as part of their own net zero and low emissions strategies.

Some of these technologies and their wider upscale has yet to be either fully functional, or adopted, yet it is obvious that the level of ambition has been set high.

International investors and the wider private sector should continue to seek opportunities to enable these countries, together with other middle and emerging economies, to aid their energy transitions and decarbonisation strategies.

While wind and solar remain for many countries the renewable energy sources of choice, their prevalence should not exclude the developing use of low emissions technologies and the opportunity to deploy hydrogen as an energy source for every country. We would urge every nation to explore how low emissions technologies and hydrogen can be part of a wider energy mix, particularly for hard to abate sectors, and in doing so, prepare national strategies for their deployment.

Just as Australia now has its Long-Term Emissions Reduction Plan, Namibia has the Harambee Prosperity Plan and Saudi Arabia the Saudi Green Initiative, every nation should seek to move beyond their own Nationally Determined Contributions and set out in detail their own net zero pathways and the role that low emissions technologies and hydrogen can play in this. Crucially, this must establish what can be done now, rather than wait years for action.

Currently, however, just 10 countries have established National Hydrogen Strategies in 2020; this is an increase compared to 3 in 208-19. Other countries that have signalled this step include Chile, with its enormous potential to scale up wind and solar power generation (potentially creating green energy seventy times greater than domestic use) for hydrogen production— which has set short and medium targets for 2025 and 2030, the EU Hydrogen Strategy published in July 2020, and the Dutch Klimat Akkoord, which has set out plans for 500Mw of hydrogen capacity for 2022-25.

National Low Emissions Technology Strategies and National Hydrogen Strategies should be developed in detail by every nation, setting out how these key enabling technologies can be deployed at scale, in order to encourage future inward investment, by setting out a clear pathway towards action.

Chapter Three

HYDROGEN DEPLOYMENT: CHOICES AND CHALLENGES

All three cases studies featured in Chapter 2 demonstrated the importance that countries from across the globe are placing on hydrogen for delivering future clean growth. If solar power and wind energy generation were the key technologies powering the first green industrial revolution, it is becoming clear that the second green industrial revolution, which will move beyond simply decarbonising electricity generation, must be centred around the use of hydrogen.

The uses of hydrogen are manifold, thanks to its flexibility. It has the capacity to be used to store seasonal renewable electricity, decarbonising industrial sectors such as steel manufacturing and could even be applied for maritime or even trucking transportation.[33]

Just as we have highlighted the deployment of hydrogen in Australia, Namibia and Saudi Arabia, the potential adoption of hydrogen is rapidly happening around the world. The UK for instance has designated hydrogen to be a pillar in its Ten-Point Plan and has announced that significant investments in hydrogen could support up to 8,000 British jobs by 2030, with the potential to unlock up to 100,000 jobs by 2050 in a high hydrogen deployment scenario.[34] Towards this goal, the government has been developing plans to construct a Hydrogen Village beginning in 2025. This village is going to be built using the lessons other innovative hydrogen-powered projects such as the H100 trial in Fife, Scotland which involved 300 homes. Should everything prove safe, profitable and more applicable than current electrifaction plans, the Government will be then moving on to developing a Hydrogen Town capable of housing tens of thousands of homes by 2030.[35]

According to the UK government, after the initial investment and deployment costs associated with radically overhauling an industry, hydrogen will have the capability of be cheaper than the current electric charging methods for Heavy Goods Vehicles (HGVs).[36]

Hydrogen has the capability of being extremely beneficial and widely applicable, especially by 2050. In a recent study by Aurora Energy Research and commissioned by Urenco, a high hydrogen usage future saw that hydrogen could provide up to 162 TWh by 2050, with a primary focus on hydrogen usage for HGVs and public transportation. The report also highlighted that hydrogen could provide up to 114 TWh by 2050 for the industrial sector, as it could be used for both high and low-grade heat applications in addition to industrial feedstock.[37]

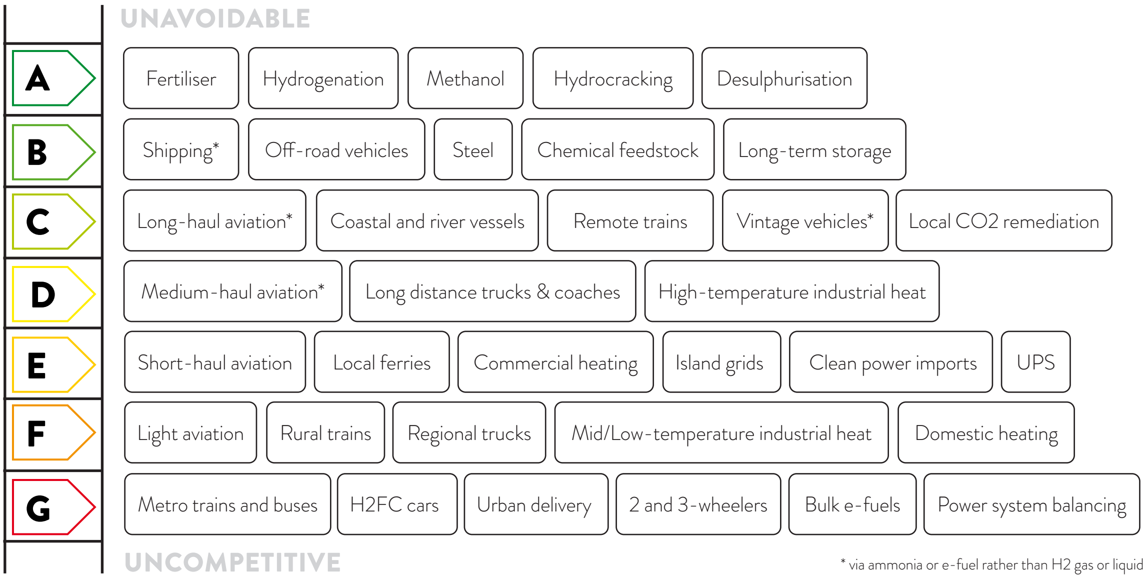
Deploying renewable energy sources and utilizing nuclear power to produce hydrogen would allow for a rapid national decarbonisation and reduce reliance on fossil fuels. According to the Aurora report, cumulative emissions from between 2021 to 2050 could be reduced by 80 megatonnes of CO2-equivalent while also reducing gas usage in power by up to 8k TWhth in some of the scenarios run in the study.

Hydrogen is also a hot stock to be looking to invest into as the volume of international investment into the hydrogen power industry has been projected to double amount to 140 million tonnes by 2030 from the current 70 million tonnes a year and rise to even 500 million tonnes by 2050.[38] According to Bloomberg, the hydrogen energy market will eventually be valued at around $700 billion by 2050.

Yet we still have a long way to go before the future opportunity that hydrogen may offer can become a reality.

As hydrogen can be used in a vast multitude of industries, it will be important to identify which ones it would be most effective to invest in today, to secure the greatest outcomes in emission reductions. In the race to net zero, hydrogen must not be placed in competition with other renewable energy generation; rather it must be

CLEAN HYDROGEN LADDER



viewed as complementary to these existing technologies, adding, not taking away, from what investment should be made in the expansion of renewable infrastructures.

Just as hydrogen should be viewed as part of a 'whole systems' approach to decarbonisation and net zero, it is also important to recognise that strategic choices need to be taken as to the scope of hydrogen deployment, to prevent technological competition creating barriers to overall emissions reductions.

We believe that heavy goods shipping, long-haul maritime shipping and heavy industrial manufacture are some industries that would most benefit from the deployment of Hydrogen as a power source. It is worth reflecting on the fact that 75% of primary energy usage lies outside the power sector[39] : it is in these industries where hydrogen, not renewable electricity, can play its most important role, potentially delivering up to 80 gigatons of carbon dioxide reductions in hard to abate sectors, 20% of clean energy needed by 2050.[40]

Internationally there are many efforts to develop hydrogen as a main energy source for heavy industries. In Sweden, for example, the Hybrit project uses hydrogen produced through renewable sources to manufacture carbon-free steel. According to the venture partners, the goal of the project is to completely reduce the carbon footprint of the sector, which would reduce the Swedish national carbon footprint by 10%.[41] Hybrit technology involves the process of replacing blast furnaces with a "direct reduction process" using hydrogen from water. This would replace the traditional carbon dioxide emissions with water vapor and allow to produce clean steel.

Prioritising the adoption of hydrogen for heavy industries such as steel and shipping may deliver the greatest possible transformations. As set out in a recent 'hydrogen ladder', we cannot ignore the fact that trade offs and choices will need to be made on how hydrogen is deployed.

Focusing hydrogen supply on the hard to abate, difficult to decarbonise heavy industries requires choices to be made as to the value of hydrogen in the energy transition. Focusing on the wider immediate deployment of hydrogen across all sectors, including cars and homes, seems an unnecessary distraction

when we can focus minds, attention and above all investment, on the correct uses of hydrogen for today's challenges. These challenges need to be balanced with the capacity and capability of technological deployment.

This requires not only every country to have a clear national action plan on their uses of hydrogen, as we have recommended, and how the future deployment of this technologies can adapt to fit the existing electricity and industrial ecosystems within each country, ensuring that there is no risk of duplication or loss of productivity and efficiency.

It also requires that at a multinational level, wider international agreement is created on the global basis by which hydrogen should not only be adopted, but traded. This requires the need not only for choices to be made, but in doing so, recognising the need for trade offs and the enabling infrastructures that are needed to ensure that the deployment of hydrogen fulfils its potential.

3.2 Incentivising and Prioritising Low Carbon Hydrogen

At COP26, one of the seven breakthrough targets that has been planned is for 25Gw electrolysed capacity hydrogen globally by 2026, aided by the establishment of a Green Hydrogen Catapult of ten international companies. If we are to reach a tipping point, however, by which signals are sent to industry to invest in hydrogen, then we need every nation to produce its own strategies, for which international benchmarks, regulations and pricing will be essential.

Currently, hydrogen remains at a disadvantage if placed in an artificial competition with traditional fossil fuels, and even solar and wind, simply in terms of price. One of the biggest barriers to a green hydrogen revolution is the amount of energy and money it takes to produce. According to a June 2020 EBRD report, hydrogen is currently more expensive than traditional fossil fuels, and producing it from those fossil fuels costs between $1-$1.8/kg while hydrogen from renewable sources can cost up to $3-$6/kg, which makes it significantly more expensive to produce and uncompetitive.[42]

Yet as we have experienced with wind and solar power, the increased demand and investment from the private sector and central government does have the potential to shift the learning curve and reduce the cost of electrolysis. The EBRD suggests that renewably sourced hydrogen could fall in price by as much to $1.5/kg by 2050 and possibly sub-$1/kg, making it competitive with current natural gas prices.

The current barrier to hydrogen today is the process by which it is created and the associated costs, both financial and in terms of energy expenditure. Green hydrogen, hydrogen produced through energy generated from renewable sources such as wind and solar power, currently costs 50% more to produce than fossil-fuel or grey hydrogen.[43] This highlights an equally important, but sometimes overlooked, area of focus: the decarbonisation of the existing hydrogen sector, for which we need greater supply side reforms (see below).

Still, the wider challenge for hydrogen appears to rest less on the supply side, with a ready number of potential projects and technologies ready for deployment; rather it is generating the demand side at sufficient scale to reach that tipping point, where the production of green hydrogen will become commercially viable, and a realistic alternative to both fossil fuels, renewables and other forms of hydrogen. Ultimately this can only be done alongside a commitment to no new fossil fuel exploration, and to seek to inflect the Keeling Curve downwards, at the lowest possible cost. Prioritising the heavy industry sectors in which this can be achieved, where electrification simply is not a feasible alternative, should be an obvious strategy.

How the demand for clean hydrogen can be further incentivised must be a central question for policy makers. It requires international acceptance and agreement that all countries should prioritise the cleanest, or green, forms of hydrogen in markets that should value low carbon intensity hydrogen.

The first priority for international agreement on hydrogen should be to prioritise the decarbonisation of the entire supply of hydrogen; this includes the existing supply of hydrogen at the same time as deploying new forms of greener, ultra-low carbon intensity hydrogen. To achieve this, however, we need to return to first principles, and redefine the taxonomy and regulations concerning hydrogen supply and use.

3.3 A New Taxonomy for Hydrogen

As it currently stands, hydrogen sourcing is broken down into a myriad of colour-coded variants including the previously mentioned 'green hydrogen', 'blue hydrogen' from carbon capture systems and 'grey hydrogen' which is most common and sourced from natural gas or methane through the process of steam reformation. Nuclear power-produced hydrogen is technically labelled as 'pink hydrogen' while other colours of the rainbow are included as well for various specifications.

The problem with the existing 'rainbow' taxonomy for hydrogen is that it confuses forms of hydrogen that have entirely different carbon pathways, often labelling them as equal when they could not be more different. For example, green hydrogen, created through water electrolysis, is treated by many countries as the same product as grey hydrogen created from steam methane reforming, despite having vastly different GHG emissions and varying amounts of hydrocarbons involved.

If we are to stimulate demand for truly clean hydrogen, rather than retain the existing and confusing taxonomy for hydrogen based on a rainbow colour methodology, there should be a new and accurate internationally agreed measurement for hydrogen based upon not the mode of production, but the intensity of carbon emissions generated in the means of production.

One possibility lies in better and more trusted certification systems for hydrogen, which in turn might aid market-based sourcing of hydrogen. Certification could be linked to the carbon intensity of hydrogen produced. For hydrogen to be properly developed and deployed in our journey towards net zero, it must be completely sourced from renewable energy, nuclear energy and systems with carbon capture and storage methods that result in low-carbon intensity hydrogen.

All hydrogen produced and used should be of the lowest possible carbon intensity and consistent with a 1.5°C scenario and net-zero society in 2050. The World Business Council for Sustainable Development's most recent report and recommendations on stimulating clean hydrogen uptake has recommended the following taxonomy (on a full life-cycle basis), adding where relevant the source of primary energy (such as renewable):

- Reduced-carbon hydrogen: ≤ 6 kg CO2eq/kg H2 or c. 50 g CO2/MJ – only relevant as a steppingstone to lower carbon hydrogen for existing higher intensity production installations
- Low-carbon hydrogen: ≤ 3 kg CO2eq/kg H2 or c. 25 g CO2/MJ
- Ultra-low carbon hydrogen: ≤1 kg CO2eq/kg H2 or c. 8 g CO2/MJ[44]

New hydrogen standards should be adopted internationally, based on the full life cycle of carbon intensity within the sourced hydrogen provide a useful framework through which to structure a global standard for hydrogen production, upon which more accurate and fair hydrogen pricing mechanisms that valued the overall outcome of emissions reductions might be based.

3.4 Better Regulations and Confidence in Hydrogen

If better, more accurate standards and grading of hydrogen is required, so too are the accountability mechanisms delivered both through regulation and regulatory bodies to uphold them. Already a number of international organisations have sought to establish common markets and regulation for the wider global deployment of hydrogen, including the Center for Hydrogen Safety and the International Partnership for Hydrogen and Fuel Cells in the Economy.

Yet we now need to witness a step-change in activity. Just as an internationally recognised new form of taxonomy is required, a UNCCC led approach to hydrogen that will deliver common approaches is required.

In order to grow confidence within the growing hydrogen market, a clear strategy is needed that will establish both international safety and technical standards which will ensure a universal recognised standard for quality and interoperability, not only for hydrogen production but also its transport, storage distribution, and ultimately end use, which might also reflect the potential for blending hydrogen.

Once these standards have been agreed, a new regulatory body or bodies would be required to provide assurance of the framework, encouraging public acceptance and confidence in a safe hydrogen market. Ideally, these standards and regulatory body would enforce the harmonisation of national standards, leading to the faster trading of hydrogen and the flow of hydrogen across borders.

Chapter Four

NUCLEAR FOR HYDROGEN

The case for nuclear power should be obvious. As a clean source of energy, it has perhaps done more for decarbonisation and reducing carbon emissions over the past seventy years than any other industrial sector. In the UK alone, nuclear power has resulted in an annual saving of 22.7 million tonnes of C02- or the equivalent of taking 1 in 3 cars off the road.[45]

Nuclear power is a source of clean, efficient, and sustainable of energy and can provide not only the highest energy capacity factor of any other energy source, but also generates zero-emission through the process of fission. If we are serious about reaching net zero and creating the most energy efficient power grind, then nuclear energy has an important role to play.

In the UK, nuclear power has not provided more than 18% of the UK's energy consumption needs since 2003, with this percentage steadily decreasing. Yet just across the channel in France, 70.6% of its energy needs come from nuclear power, allowing it to have multiple strong sources of clean energy without any serious concern for the last 40 years.[46]

It is worth reflecting on France's own nuclear transformation between 1973, when around 3% of electricity supply came from nuclear, to 1986, when 60% market share was reached. A mission based, state driven, uncompromising approach to nuclear deployment resulted in a wholescale transformation of the energy grid in France within thirteen years. One might argue that we now need a transformation on a similar scale, with even greater urgency, to decarbonise our energy sectors.

It is important, however, to recognise that in the past, public perception of nuclear power, both in the UK and in other countries internationally, has acted as a barrier to the common acceptance of the potential that this technology has to offer. While nuclear remains a safe source of energy, more should be done at a government and industry level to improve public confidence in this technology, both through public information campaigns, and in fostering greater understanding both at school and in local communities of the benefits of nuclear power as a source of clean energy. Only by understanding people's fears and listening to concerns can they be alleviated. Only by working with people's concerns and fears, demonstrating that modern day nuclear power is a clean source of power that delivers both constant and secure energy, can we ensure that nuclear will have a secure future for the next century.

Yet public perception and confidence is by no means the only barrier to the successful delivery of nuclear sources of energy in the future. Through lack of leadership and strategic direction, Britain's nuclear power plant fleet is ageing and on the brink of collapse. Without the nuclear fleet, renewable sources will fail to address this shortcoming and we may be forced to increase our reliance on foreign fossil fuels and reduce the gains we have made so far in our journey towards net zero.

The UK is facing an increasingly likely scenario where by March 2024, five of the UK's eight nuclear power plants are to be decommissioned and switched off, and 12 out of 13 reactors by 2030. According to the Nuclear Industry Association this would result in the UK losing 10% of its nuclear-powered energy, stalling decarbonisation and forcing current wind turbine projects to, at best, maintain the current progress instead of increasing our progress to net zero by 2050.[47]

In the past, the prohibitive upfront costs of nuclear investment has prevented commitments from coming far sooner: yet this has now begun to change. While discussion on nuclear has focused on its overall cost, the changing geopolitical situation has resulted in countries recognising that they cannot put a price on the security and independence of their energy supply. At the same time, new financial models have been developed that will ensure both a realistic funding mechanism for nuclear construction, underpinned by domestic, rather than international, investment. The UK is currently taking through legislation in Parliament to finance a new generation of nuclear reactors, starting with Sizewell C in Suffolk, adopting the Regulated Asset Base model, which potentially will save £30billion over the lifetime of a nuclear plant building project, while ensuring that the UK's new nuclear fleet can be financed domestically rather than through international investment. In France, which had previously voted to reduce its nuclear contribution to 50%, President Macron has now committed to new modular nuclear reactors as part of his 'France 2030' regeneration plan, explicitly citing independence of energy supply as the reason.[48]

Perhaps one reason for both the UK and France to be reconsidering their approaches to nuclear are the exciting technological revolution within the industry in the form of Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs). With world-leading companies such as Rolls-Royce, Westinghouse, NuScale Power, Urenco and the South Korean firm GF Nuclear, SMR technology has the potential to close energy circuits around heavy industries and other power generation, like hydrogen.

In the UK alone, SMR investment, development and deployment is estimated to be able to create up to 40,000 new jobs and add £52 billion to the UK economy. Due to their size and design, many SMR projects are being developed with the benefit coming in the form of the building multiple SMR plants in one location and then shipping them internationally, potentially adding £250 billion in exports.[49] This type of nuclear power station could easily be the primary energy source for heave manufacturing industries while also providing the necessary power to make hydrogen into a usable energy source.

AMR technology is designed to be able to be used in more remote areas of the country where traditional nuclear energy sites would be impossible in part because they are smaller and seen to be more efficient that their traditional counterparts.[50] In July 2020, the UK government announced plans to invest £40 million into funding to support 3 AMR projects which could provide thousands of green jobs and reduce the energy sector's carbon footprint.[51]

In a follow up assessment study, the Department For Business, Energy & Industrial Strategy announced the results of a research paper into the technical assessment of AMR technology. Released in July 2021, this paper concluded that High Temperature Gas Reactors (HTGRs) were the preferred AMR for the UK government's AMR R&D demonstration program due to their high potential to make "a significant contribution to Net Zero by 2050 via multiple energy vectors."[52]

HTGR reactors will be able to produce low-carbon hydrogen while also producing extremely high temperatures which would have the potential of powering district heating networks by the 2040s. As a large amount of international carbon emissions comes directly from heat generation, the ability to produce extremely hot temperatures in a low-carbon manner will be invaluable.[53]

4.1: Nuclear for Hydrogen: Redefining the role of Nuclear

It is this future use of nuclear power that has the greatest potential to revolutionise the sector: not to view nuclear for nuclear's sake, supplying its own form of energy and in turn electricity generation, but most importantly as a flexible advanced heat source.

Heat generated from fission, as an advanced heat source, can both be used for the production of electricity when needed on the grid, but when it is not required, the use of heat can be turned to the production of hydrogen, ensuring that the production of both electricity and hydrogen is complementary.

Nuclear, or advanced heat sources, therefore not only provides the constant baseload of electricity generation needed for heavy industries such as steel, it can be deployed to produce hydrogen at scale. The deployment of nuclear and hydrogen have the potential to become mutually inseparable. Indeed nuclear could be the answer to delivering the mass production of hydrogen that, unlike current forms of hydrogen derived from fossil fuel production, can truly be classified as a clean hydrogen source.

Roundtable discussions focused in particular on the modelling produced by the Aurora Energy Research's hydrogen study, that has mapped out a new AER model representing the potential for nuclear energy to generate heat, hydrogen and power through a 'flexgen' approach- through which both power and heat could be produced through nuclear fission, both of which would aid the high heat electrolysis of hydrogen. New electrolysers in development, which would be deployed under high temperatures, have demonstrated 90% efficiency levels, compared with 65% efficiency of current electrolysers.

If this latest technology is deployed at a wider scale, nuclear's role in net zero might be not just as a clean source of power, but as an enabler for hydrogen to be deployed at scale, through low emissions and low cost. Adopting the latest AER model mentioned, Nuclear for Hydrogen should be a strong focus for future policy makers, and a feature of discussion at COP26.

This is not to suggest that nuclear and hydrogen strategies should sit separately from the wider deployment of renewables; nuclear should complement mainstream decarbonisation approaches by enabling renewable deployment without gas fired generation. What cannot be ignored is the fact that the liquid fuel market as it currently stands is four times larger than the current electricity supply. It cannot be reasonable to suggest that wind and solar alone can supply enough hydrogen to meet future market potential demand if hydrogen replaces fossil fuels.

Nuclear provides a ready and reliable source of hydrogen that can meet this opportunity. At the same time, if we assume that fossil fuels are to be replaced by renewables on the pathway to net zero, the reality is that we would need approximately 10-times as much renewable energy in the next 28 years as has been built in the last 20 years. It simply is not sustainable that wind and solar or other renewable sources of energy can deliver this, especially since deployment rates for renewables are already below that necessary to achieve 2050 decarbonisation targets.

We need every tool, every technology in our arsenal to achieve net zero. We cannot afford to side line nuclear power, particularly at a time when innovation in advance sources of heat and hydrogen production could see nuclear become the key to unlocking hydrogen production. COP26 should open its eyes to the combined value of nuclear and hydrogen as a complementary strategy alongside renewable energy.

EDF CASE STUDY

Nuclear has reduced global CO2 emissions by 60 gigatonnes in the last 50 years (the equivalent of about 2 years of energy usage) and is currently the second-largest source of low-carbon electricity, providing roughly 10 per cent of the global electricity supply in 2018. As 2050 draws ever closer nuclear is set to play a key role in providing stable and reliable energy that is both scalable and minimally carbon-intensive, and the importance of implementing nuclear in a forward-thinking manner is showcased in the EDF's plans for Hinkley C in Somerset.

One of the world's leading nuclear power providers, EDF is intimately involved in nuclear power in the UK, being the majority shareholder of Hinkley Point C and also running nearly every current nuclear power station in the country. The first new nuclear power station to be built in the UK in over 20 years, Hinkley Point C in Somerset will provide low-carbon electricity for roughly 6 million homes while creating 25,000 jobs and 1,000 apprenticeships. Simultaneously providing the impetus for a green transition and economic growth, its two EPR reactors will provide cleaner energy that will offset over 9 million tonnes of carbon dioxide emissions a year - and will be designed to increase biodiversity and address issues with shorelines and wetlands.

However, while addressing issues with the surrounding environment and the immediate need for reliable clean energy are key elements of the Hinkley C project, so too is the education and training of the plant's operators. The plant will first launch as a single reactor, though a second is planned, in an intentional move that will look to drive down the second reactor's cost of training and human resources by reducing the skill gap. As such, Hinkley Point C will be created through sequenced development that utilises the infrastructure of the first reactor (and programs such as the Hinkley Connection adult skills program) to ease the second reactor's creation. It is a move that public and private sector leaders hope will engender a snowball effect within the UK's nuclear industry and could potentially establish a blueprint for drastically reducing the cost of building new low-carbon energy infrastructure.

- Hinkley Point C's reactors will have a nameplate capacity of 3,260 MWe. This capacity will make Hinkley Point C competitive with some of the largest hydroelectric projects, despite the nameplate capacity being significantly smaller, as nuclear plants benefit from high capacity factors (nearly always >90 per cent).
- The large core of the EPR reactor means it uses 17 per cent less uranium than older technology.

Chapter Five

CONCLUSION

Ultimately, this Maximising COP26 Report reflects the need for an inclusive climate policy that recognises each country will decarbonise its economy starting at very different starting points from each other. We must listen and engage with those who, through no fault of their own, either work in high carbon industries, or live in high carbon countries. It is only by working with these communities and countries, that we will deliver the global outcomes which we all are seeking: real-terms reduction in carbon dioxide emissions, in real time.

Just as we need to take an inclusive approach to international climate dialogue, so too we must make an inclusive strategy that recognises the importance of every technology that can deliver clean energy. To prioritise one form of renewable technology over another risks at best slowing, at worst threatening, the pace of decarbonisation across the globe.

There has been, rightly, a strong focus on the potential that hydrogen has to offer hard to abate sectors in their decarbonisation journeys, particularly those which will be unable to do so by renewable electricity alone. This report highlights how different countries have adopted separate hydrogen strategies, yet are doing so to work with their emerging and growing economies, and not against them.

There is in addition a clear focus in this report on the importance that nuclear power must play as a source of clean energy, but also as a facilitator of other forms of clean energy such as hydrogen. At the same time, an approach that recognises that each country and community will be on their own separate journeys, depending on how invested their economies have been in technologies and energy sources of the past, is essential.

Low emissions technologies can aid the decarbonisation of both heavy industry and the energy grid, yet we must also seek to ensure that as coal is phased out, we manage this transition by seeking to deliver real time carbon emissions reductions through adaptation of existing infrastructures- and not waiting simply for them to close in the distant future.

As we emerge from the Pandemic, political leadership will be vital in Glasgow for COP26. The issue of climate change cannot and will not be solved with only a small number of countries pulling their weight – this is a matter which every country has a role to play: from the United States, China, the United Kingdom to South Africa and Sri Lanka.

A united international goal of this magnitude is the challenge of our generation, and should we be successful it will be the responsibility of the generations to follow to maintain it. But we must reach a meaningful position first, while also avoiding empty political slogans. Much like running a business, we have a plan, and we have international pledges but currently we are lacking in leadership and accountability, hoping that each country acts in their own best interest.

We must be prepared to build back differently and put ourselves in the best situation to foster an environment which is both great for business and national standard of living, but also one that is environmentally sustainable and reduces carbon emissions. Democracies all over the world are rallying behind programs under the slogan "Build Back Better", and while the sentiment of this is commendable, we must face the realities that this 'rebuild' will entail.

It is therefore crucial that we objectively analyse and utilize every available technology at our disposal to reduce our carbon footprint. At present, our armoury is quite bare and susceptible to unprecedented energy pricing crunches, due in part to our reliance on solely wind and solar power as forms of 'sustainable' energy. While wind and solar power will be crucial moving forward, we must also recognise that their availability is limited to when there is sufficient wind or during the light-shining days. To supplement the inherent shortcomings of these technologies, we must look to develop and deploy nuclear power, hydrogen power and carbon capture and underground storage technologies. Only through a multi-pronged approach can we stand a chance in the fight to reducing carbon emissions to the net zero goal by 2050.

A new climate settlement is needed: one in which we utilise all forms of technology, and one in which we do not seek to divide nations. It must be a settlement that also prioritises the present over the distant future: annual emissions reductions should take priority over distant net zero commitments.

If we are to maximise COP26, we need to take every country with us, and to take up all forms of technology that can aid decarbonisation now— delivering real time and real-world results. As T.S.Eliot once wrote, we cannot waste our time “dreaming of systems so perfect that no one will need to be good”. We can act now, if we accept that we must deliver for all countries, accepting in good faith that we cannot make the perfect the enemy of the good.

Appendix

ROUNDTABLE PARTICIPANTS

PPP is grateful to the below participants who gave the time at the following roundtables

INNOVATING FOR NET-ZERO: LOW EMISSIONS TECHNOLOGIES – HELD ON 7TH SEPTEMBER 2021

Webinar led by:
- H.E. The Hon. George Brandis QC, The High Commissioner of The Commonwealth of Australia to the UK
- Dr Alan Finkel AO, Special Advisor to The Government of Australia on Low Emissions Technologies
- Anthony Johnson, Partner, Ashurst LLP

Participants:
- (Chair) The Rt Hon Amber Rudd, Deputy Chair, Public Policy Projects
- The Rt Hon Chris Skidmore MP, former UK Minister for Science, Innovation and Universities H.E.
- The Hon. George Brandis QC, High Commissioner of Australia to the UK
- Dr Alan Finkel AO, Special Advisor to the Australian Government on Low Emissions Technology
- Hideo Suzuki, Managing Executive Officer, Nippon Steel
- Guy Desai, Managing Director, CIBC Capital Markets
- Jeff Lynn, Partner, Ashurst LLP
- Peter Godfrey, Managing Director, The Energy Institute
- David McCredie, Chief Executive Officer, Australian British Chamber of Commerce

TRANSITIONING TO GREEN: HYDROGEN ROUNDTABLE – HELD ON 27TH OCTOBER 2021

Webinar led by:
- H.E. Mrs Linda Scott, High Commissioner of Namibia to the UK
- James Mynupe, National Hydrogen Spokesperson of Namibia
- Charlotte Fenton, Deputy British High Commissioner to Namibia

Participants:
- (Chair) The Rt Hon Amber Rudd, Deputy Chair, Public Policy Projects
- The Rt Hon Chris Skidmore MP, former UK Minister for Science, Innovation and Universities; Director of Policy, Public Policy Projects
- The Rt Hon Claire O'Neill, Managing Director, World Business Council for Sustainable Development; Senior Advisor, Public Policy Projects
- Dr Dean Bialek, Head, International Politics Unit, COP26 Climate Champions Team
- H.E. Mr David Gallagher, Ambassador of Chile to the United Kingdom
- H.E. Mr Abdesselam Aboudrar, Ambassador of The Kingdom of Morocco to the United Kingdom
- James Mynupe, Economic Advisor to the President of Namibia; Namibia's National Hydrogen Spokesperson
- James Patterson, Vice-President, Green Hydrogen, British Petroleum
- Dr Uwe Remme, Head of Hydrogen and Alternative Fuels, International Energy Agency
- Allan Baker, Global Head of Power, Societe Generale
- Brett Ryan, Hydrogen Technical Principal Consultant, Gemserv
- Nick Wayth, Chief Executive Officer, Energy Institute
- Daria Nochevnik, Director of Policy, Hydrogen Council
- Massimo Giachino, Head of OPC Risk Engineering Services, Swiss Re
- Nick Ash, Associate Director, Arup
- Caroline Amblard, Manager, Hydrogen Pathfinder, World Business Council for Sustainable Development

Appendix

ROUNDTABLE PARTICIPANTS

POWERING THE WORLD IN 2050: NUCLEAR ROUNDTABLE HELD ON 29TH JUNE 2021

Webinar led by:

- H.E. Ms Catherine Colonna, Ambassador of The Republic of France to the UK
- Simone Rossi, CEO, EDF Energy

Participants:

- (Chair) The Rt Hon Amber Rudd, Deputy Chair, Public Policy Projects
- The Rt Hon Claire Perry O'Neill, Senior Advisor, Public Policy Projects
- Alain Kilajian, Youth Ambassador, One Young World
- Boris Schucht, CEO, URENCO
- Paul Spence, Director for Strategy, EDF
- Kirsty Gogan, Executive Director, Energy for Humanity
- Tom Greatrex, CEO, Nuclear Industry Association
- Keisuke Sadamori, Director of Energy Markets and Security, International Energy Agency
- The Baroness Worthington, Founder, Quadrature Climate Foundation
- Duncan Burt, COP26 Director, National Grid Group
- Emily Gosden, Energy Editor, The Times
- Jennifer Gordon, Managing Editor and Senior Fellow, Atlantic Council
- Pierre-Yves Cordier, Nuclear Counsellor, Embassy of The French Republic to the UK
- Andrea Waldman Lockwood, Deputy Assistant Secretary for Europe, Eurasia, Africa and the Middle East, US Department of Energy
- Tomasz Nowacki, Director of the Nuclear Energy Department of the Ministry of Climate and Environment, Poland
- Kentaro Funaki, Executive Director, Japan Atomic Energy Agency
- Professor Kamal J. Araj, Deputy Chairman, Jordanian Atomic Energy Commission
- Prof. Dr. Amged El-Wakeel, Nuclear Power Plants Authority, Egypt

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