MOD, Team Defence Supported, Hydrogen Conference

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Output Report

Guided by

Strategic Command

Organised by

TEAM DEFENCE INFORMATION
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ACKNOWLEDGEMENTS

This conference would not have been possible without the dedication and meticulous work by Team Defence Information, StratCom, OEA and the sponsorship by the electrolyser innovators, Wastewater Fuels Ltd. Furthermore, special thanks to the speakers for giving their time and expertise in the name of education and collaboration.

Speakers from the following organisations participated in the conference:

EXECUTIVE SUMMARY

The MOD, Team Defence Supported, Hydrogen Conference, sponsored by Wastewater Fuels, brought together leading industry, academic, and military experts to explore, hypothetically, the potential of hydrogen as a renewable energy source and its application in transforming the Falkland Islands which was chosen as a real-life scenario because of the extreme distance from the UK, its strategic importance and its challenging situation and environment. The conference aimed to find innovative solutions to make the Falkland Islands more sustainable, self-sufficient, and eco-friendly for its energy while reducing reliance on fossil fuels and reducing military expenditure and logistics burden on fuel imports.

The Falkland Islands face significant economic and environmental challenges due to their reliance on imported fossil fuels. The envisioned future includes, amongst others, leveraging hydrogen technology to create a sustainable energy ecosystem, reduce carbon emissions, and enhance energy security. Key outcomes of the conference included identifying strategies for implementing hydrogen technology and fostering collaborations to drive environmental and economic improvements. This would not have been possible without the expert speakers, collaborative attendees and the British Forces South Atlantic Islands (BFSAI), Falkland Islands, engagement.

1. INTRODUCTION

The Defence Hydrogen Committee, established in November 2022, provides strategic guidance and leadership to cohere innovation and thinking towards Defence hydrogen operational capability. The Committee is chaired by Strategic Command (StratCom) Operational Energy Authority (OEA) which manages operational energy across Defence, preparing for energy transition away from fossil fuels. It upholds the Defence Operational Energy Strategy (DOES) that considers implications across the full energy enterprise required to support those operational energy choices. The Committee has a coordinating relationship with Defence Estate Energy Strategy to ensure the estate energy strategy and the operational energy strategy are coherent and complementary The Committee is further guided by the Defence Climate Change and Sustainability Strategic Approach which aims to reduce emissions and aligns with the UK Government's commitment to net-zero greenhouse gas emissions by 2050.

Team Defence bridges MOD with various stakeholders to create trusted support solutions. Wastewater Fuels Ltd is developing modular and scalable technology for on-grid and off-grid applications that produce clean energy and water from wastewater. Please refer to Appendix A for the list of participating organisations.

2. OBJECTIVES OF THE CONFERENCE

The conference is an industry engagement event facilitating collaborations between industry, academia, and military stakeholders to consider how, hypothetically, one of its overseas deployed locations could be run as a zero-emission, self-sufficient location by 2050, based on hydrogen and other renewable energies (Figure 1). The ambition necessitates transitioning to a complex and diverse energy mix devoid of fossil fuels without compromising Defence capability. The conference aimed to address these challenges by:

- Discussing the potential of hydrogen as a renewable energy source.
- Exploring the feasibility of implementing hydrogen technology on the Falkland Islands.
- Identifying strategies to enhance sustainability, self-sufficiency, and eco-friendliness.

SCENARIO

Our doctrine and allocation of resource is influenced by the challenges of our time - global warming, resource shortage, and evolving geo-political instability.

Self-sufficiency is a far-reaching topic. It will permeate through everything the Ministry of Defence and our allies endeavour to achieve, as we strive to deliver Net Zero, whilst continuing to maintain its core functions of defence of the realm, peacekeeping and humanitarian support.

Self-sufficiency is a strategic advantage, and net zero commitment is the right and necessary thing to do.

At this conference, you'll support us to shape a journey together, answering the question - how can military and industry collaborate to over-come one of our biggest 21st century challenges – climate change and sustainability.

Our goal together – make operations on the Falklands of net zero emissions and self-sufficient for energy.

As the song goes "If I can make it there, I'll make it, anywhere"; solving net zero and self-sufficiency here will generate solutions and collaborations that can be applied across the global.

The conference will focus on the holistic and connected eco-system that should come together to realise a net zero and self-sufficient vision for the Falklands based on hydrogen.

Attendance is by invite only. We are assembling expertise in all the pieces of the puzzle from sustainable energy generation all the way to distribution of the synthetic fuels. You have been selected to provide valued input and join our expedition towards net zero and self-sufficiency.

Dr. Joseph Lam

Chair of the Defence Hydrogen Committee

Operational Energy Authority

Strategic Command

Ministry of Defence

Figure 1: The conference invite with the 'SCENARIO' context.

3. THE FALKLAND ISLANDS

The Falkland Islands are a self-governing British overseas territory in the South Atlantic Ocean which consist of two main islands, East Falkland and West Falkland, and numerous smaller islands. The islands are home to half a million sheep and one million penguins. Defence has a sizeable presence on the Falkland Islands. Please refer to Appendix C for further details on the Falkland Islands.

The Falkland Islands face significant environmental challenges, primarily water scarcity. The existing sewage infrastructure, road infrastructure and power and transmission infrastructure need updating, as they were designed for a much smaller population. Please refer to Appendix D for further details on environmental and infrastructure challenges on the Falkland Islands.

Several initiatives are underway or being explored to enhance sustainability and energy efficiency. Camp resilience is a concern and there is an interest in deploying small, non-rotating turbines to minimise radar interference on and around the base for distributed energy generation. Please refer to Appendix E for further details on future initiatives on the Falkland Islands.

Key Facts and Figures:

- The Falkland Islands are one of the windiest places in the world with an average wind power density of more than 1400 W/m^2.
- The Falkland Islands operations consume approximately 41,500 m^3 of aviation fuel and 40,300 m^3 of diesel annually.
- The Falkland Islands have three operational wind turbines, which, when fully functional, can provide 5% of the annual energy needs. This could increase to 10% with battery integration.
- The average energy demand on the islands is between 3-5.5 MW.
- Most of the infrastructure was built in the 1980s and needs to be better insulated, contributing to high energy consumption for heating.

4. TRANSFORMING THE FALKLAND ISLANDS USING HYDROGEN

The envisioned scenario involves transforming the Falkland Islands into an early adopter of hydrogen, achieving sustainability, self-sufficiency, and eco-friendliness. Utilising hydrogen to reduce carbon emissions and decrease reliance on fossil fuels contributes significantly to global climate goals. Integrating hydrogen into Falkland Islands' energy mix can make substantial progress towards a more sustainable future. Developing local hydrogen production capabilities is crucial for ensuring energy security. Reducing the need for imported fuels can enhance Falkland Islands self-sufficiency and bolster their energy independence. Please refer to Appendix B for a summary on the current state of hydrogen technology.

Implementing hydrogen technology in a manner that harmonises with the local environment is essential. This approach helps preserve unique ecosystems and ensures that the advancements do not come at the cost of environmental degradation. Hydrogen technology promises to reduce fuel costs and create new economic opportunities. It can stimulate economic growth and improve economic efficiency by fostering new technologies and industries.

Ensuring the safety of hydrogen production, storage, and use is paramount. This requires robust infrastructure and stringent regulatory frameworks to mitigate risks and protect people and properties. Establishing the Falkland Islands as a model for hydrogen adoption and innovation can attract investments and partnerships. Defence can become a beacon of progress and sustainability by positioning itself at the forefront of this emerging field.

The successful implementation of this vision requires collaboration between various stakeholders, investment in infrastructure and technology, and a commitment to sustainability and innovation. Key strategies include installing additional wind turbines, developing electrolysis facilities, and building synthetic fuel production plants.

Please refer to Appendix F for assumptions for the Falklands Islands Net Zero and Self-Sufficient (NZSS) scenario. Figure 2 shows the envisioned future scenario of Falkland Islands.

a

b

Figure 2: Envisioned future scenario of Falkland Islands: (a) a 3D mock-up model and (b) artist impression of the scenario.

5. TABLE THEMES, AGENDA AND DELEGATES

With input from personnel currently stationed on the Falkland Islands, Team Defence and Wastewater Fuels were able to extract vital information about the current Falkland Islands' energy situation and their energy aspiration. These conversations were vital to creating the key focus areas (Figure 3) and table themes of interest for the workshop discussions (Figure 4).

The right mix of delegates was critical to the conference. Three groups of delegates were invited to the conference. They were industry delegates, academic delegates and military delegates. Industry delegates provided insights into technological innovations and practical implementations. Wastewater Fuels Ltd highlighted the potential of microbial electrolysis cells (MEC) for wastewater treatment and hydrogen production. 2G Energy Ltd discussed the feasibility of CHP engines running on biogas and hydrogen. Rheinmetall focused on synthetic fuel production using carbon capture and hydrogen. Geopura presented mobile and scalable hydrogen power units.

Academic delegates emphasised the importance of research and development. The University of Exeter stressed the need for comprehensive studies on renewable energy integration and hydrogen production. The University of Southampton highlighted the potential for collaboration in hydrogen technology research.

The military provided strategic perspectives and logistical considerations. StratCom emphasised the importance of energy security and the potential of hydrogen to reduce reliance on imported fuels. The RAF, Royal Navy, and Army discussed the logistical challenges and opportunities for integrating hydrogen technology into military operations.

The conference agenda was designed around the table themes (Figure 5). First half of the morning session was briefings from Defence on their requirements, visions and aspirations. Second half of the morning session was briefing from industry covering selected table themes. Please refer to Appendix G for the conference presentation pack. Workshop session by table themes was held in the afternoon.

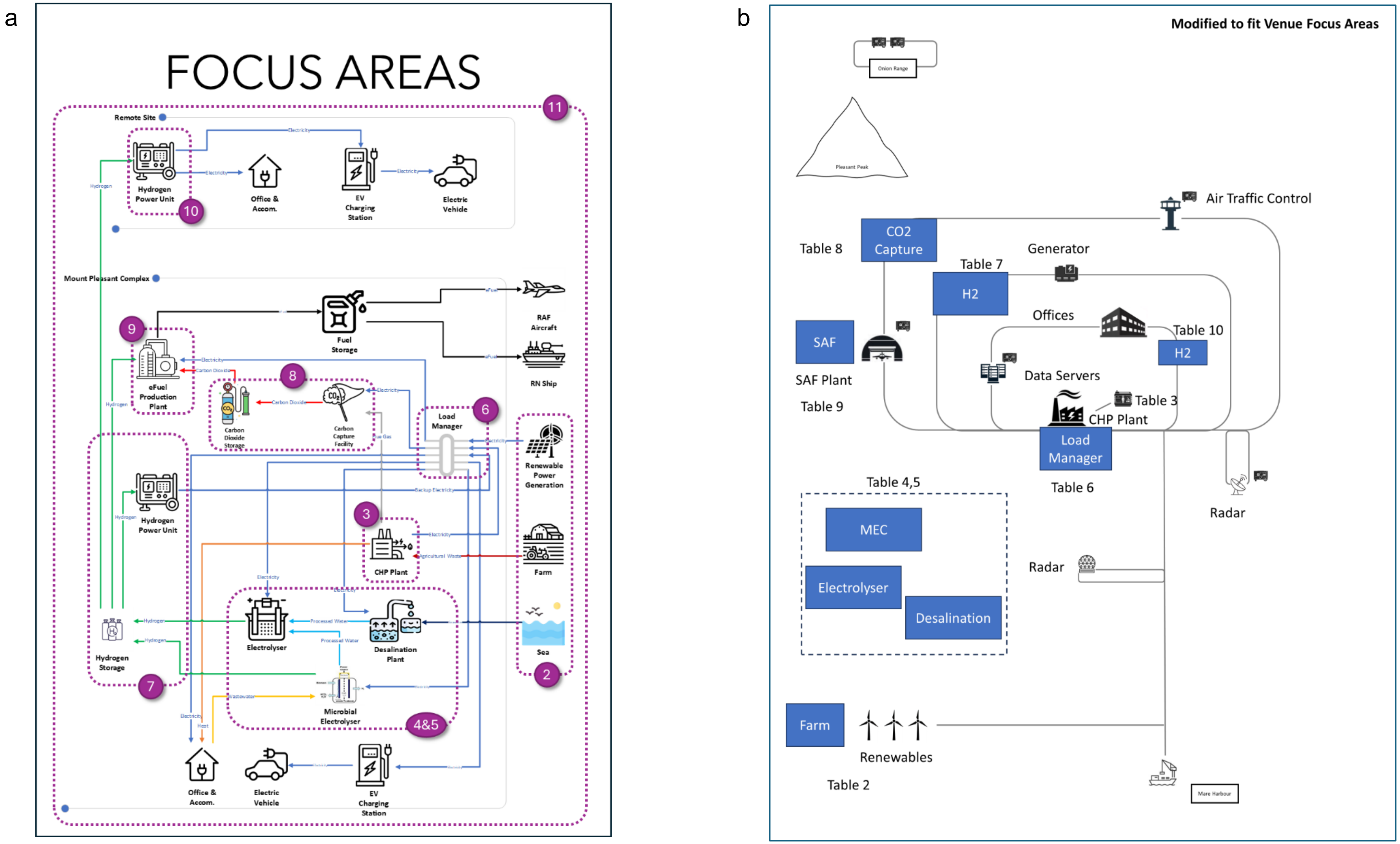

Figure 3:Schematic of the future vision of the Falkland Islands: (a) table number with their focus areas and (b) the 3D model pictogram co-created with the Falklands personnel.

Table 02	**Renewable power generation**
Table 03	**CHP Engines**
Table 04	**Electrolysers & The Water Cycle**
Table 05	**Electrolysers & The Water Cycle (table 2)**
Table 06	**Load Management**
Table 07	**Hydrogen Storage & Transportation, & Conversion to Electricity**
Table 08	**Carbon Capture & Storage**
Table 09	**Synthetic Fuel Production**
Table 10	**Fuel Cells**
Table 11	**Scheme Financing, Management & Construction**

Figure 4: The workshop tables with their focus areas.

Time	Topic	Organisation	Speaker
08.30-08.55	Coffee & Registration	Wastewater Fuels	NA
09.00-09.05	Welcome and site safety	Wastewater Fuels	Paul Glenister
09.05-09.10	Introduction and role to support MOD	1 - Team Defence	Darin Tudor
09.10-09.20	Conference opening	2 – StratCom	Colonel Pete Skinsley - Deputy Head, Operational Energy Authority
09.20–09.30	Current activities and plans	3 - StratCom	Flight Lieutenant Richard Griffiths
09.30-09.40	RAF vision	4 - RAF	Group Captain Maurice Dixon
09.40-09.50	Royal Navy vision	5 – Royal Nay	Lisa Hammock
09.50-10.00	Army vision	7 - Army	Michael Holman
10.00-10.10	DIO vision	8 - Defence Infrastructure Organisation (DIO)	Jeremy Obbard – MOD DIO
10.10-10.50	Coffee		
10.50-11.10	Synthetic Fuels Production (including carbon capture)	9 - Rheinmetall	Rob Rider
11.10 – 11.30	Microbial Electrolysers/wastewater processing	10 – Wastewater Fuels	Dr. Daniel Carlotta-Jones
11.30-11.50	Hydrogen supply and hydrogen infrastructure	10 – Ryze Hydrogen	Jake Harding
11.50-12.10	Hydrogen Power Units	11 - Geopura	Matthew Barney
12.10-12.30	Liquid Organic Hydrogen Carrier	12 - Exolum	Henry Story
12.30–13.50	Networking Lunch		
13.50 – 13.55	Falkland Islands – Context for the workshops	Flight Lieutenant Richard Griffiths	
13.55-15.20	Workshops	By table themes supporting the vision from the MOD presentations (Running refreshments)	
15.20-15.50	Plenary	Workshop leads	Westwater Waste Team
15.50-16.00	Closing remarks		StratCom and Team Defence
1.600	Dispersal		

Figure 5: Conference agenda.

6. THEMED TABLE DISCUSSIONS

The workshop session of the conference allowed delegates to dive deeply into specific focus areas relevant to the Falkland Islands scenario. Participating organisations at each themed table are given in Appendix A. Each table was assigned a focus area and tasked with solving related problem questions. Table 1 was the organiser's table, and the themed tables were therefore numbered from 2 to 11. Each table consisted of military, industry and academic delegates, and their discussions were captured by a Wastewater Fuels operative. The following summarises the critical discussions and outcomes from each themed table.

6.1 Table2: Renewable Power Generation

The focus was on integrating various renewable energy sources, including wind, solar, geothermal, and tidal power with hydrogen technology to ensure a stable energy supply.

Renewable Energy Expansion:

The delegates emphasised the importance of increasing the number of wind turbines and solar panels. They discussed the potential of geothermal and tidal power as additional renewable sources. Integrating these renewable sources with hydrogen technology ensured a stable and sustainable energy supply.

Hydrogen Production and Storage:

Developing large-scale electrolysis facilities for hydrogen production was highlighted as a critical priority. Establishing a comprehensive hydrogen storage and distribution network was essential for effectively utilising hydrogen. The integration of hydrogen technology with existing energy systems and infrastructure was also discussed, focusing on creating a seamless transition to renewable energy.

Government and Regulatory Support:

The emphasis was on securing government grants and subsidies to support hydrogen projects. Delegates discussed the need for regulatory compliance to ensure safety and standardisation. The role of financial incentives in encouraging businesses and individuals to adopt hydrogen technology was also considered crucial.

Table 2: Renewable Power Generation	
Challenges	*Solutions*
▪ Obtaining environmental permits for renewable energy projects. ▪ Geopolitical conflicts affecting energy security and project timelines. ▪ Developing infrastructure for large-scale renewable energy generation. ▪ Transitioning from diesel to renewable energy sources.	▪ Engage with environmental bodies early to streamline the permitting process. ▪ Develop phased infrastructure plans to increase renewable energy capacity gradually. ▪ Utilise advanced weather forecasting and energy management systems to

	optimise renewable energy production. ▪ Implement educational campaigns to promote the benefits of renewable energy.

6.2 Table 3: CHP Engines

Discussions centred on the feasibility and implementation of Combined Heat and Power (CHP) engines, integrating them with hydrogen production to maximise efficiency, and addressing challenges related to scaling, political buy-in, and funding.

Challenges and Solutions:

Key challenges included ensuring the system is scaled to meet future demands, transitioning from diesel to a suitable mix of energy sources (biogas and hydrogen), and securing political and financial support from the Falkland Islands Government, MOD, and international organisations. Monitoring load demand and management to understand energy and power requirements was also highlighted.

Implementation Strategies:

The modular design of CHP systems was highlighted for easy and effective expansion. Building resilience into the systems through N+1 redundancy, where an additional component is available to support a failure, was considered essential. Training military and island personnel for CHP system operation and maintenance (O&M) was also discussed.

Economic and Environmental Impact:

The economic impact of CHP systems was considered significant. Potential benefits included a cheaper and more resilient power supply, job creation, and positioning the Falkland Islands as a showcase for low-carbon technology. Environmental benefits included reduced carbon emissions and improved air quality. The integration of CHP systems with renewable energy sources and district heating schemes to provide heat and hot water to communities was also discussed.

Table 3: CHP Engines	
Challenges	*Solutions*
▪ Scaling up CHP engines to meet the 2040 targets. ▪ Transitioning from diesel-based systems to hydrogen and biogas. ▪ Gaining political buy-in for new technologies. ▪ Securing funding for large-scale deployment.	▪ Develop modular CHP systems that can be scaled up as needed. ▪ Provide training programs for CHP systems' operation and maintenance (O&M). ▪ Implement district heating schemes to increase efficiency and reduce costs.

	▪ Secure public and private sector funding through partnerships and grants.

6.3 Tables 4 and 5: Electrolysers and The Water Cycle

Delegates discussed best practices for electrolysers, managing the water cycle for continuous hydrogen production, and ensuring hydrogen purity and suitability. They also discussed water supply, infrastructure, and economic viability challenges.

Best Practices for Electrolysers:

Using electrolysers with renewable energy and avoiding significant water losses were emphasised. Hydrogen production should be aligned with peak renewable energy production times to maximise renewable energy utilisation. Storing hydrogen to ensure a continuous power supply during low renewable energy production periods was considered essential.

Water Cycle Management:

Managing the water cycle for continuous hydrogen production involved addressing water leakage issues and ensuring a constant water supply. The need for detailed flow and load surveys was discussed to understand the required capacity for sewage treatment works. Upgrades to the treatment capacity of sewage treatment infrastructure were considered necessary to meet future demands.

Economic and Environmental Impact:

The financial benefits included reduced reliance on imported diesel and potential job creation, while the costs involved significant initial investment in infrastructure and technology. The environmental benefits included reduced carbon emissions and improved water quality. Integrating electrolysers with renewable energy sources was a critical strategy for achieving sustainability goals.

Table 4: Electrolysers & the Water Cycle	
Challenges	*Solutions*
▪ Ensuring a reliable water supply for electrolysis. ▪ Addressing stack failures in electrolysers. ▪ Upgrading sewage treatment facilities to support hydrogen production.	▪ Address water leakages and improve water management practices. ▪ Deploy advanced electrolysis technologies with higher reliability and efficiency. ▪ Upgrade sewage treatment facilities to incorporate hydrogen production processes. ▪ Prioritise the deployment of renewable energy sources to power electrolysis.

Table 5: Electrolysers & the Water Cycle	
Challenges	*Solutions*
▪ Managing supply chain length for equipment and materials. ▪ Lack of potable water for electrolysis. ▪ Efficient energy distribution and grid integration.	▪ Utilise wind and solar power to supplement hydrogen production. ▪ Implement microbial electrolysis cells (MEC) for wastewater processing. ▪ Develop hydrogen storage and distribution systems to ensure a steady supply.

6.4 Table 6: Load Management

Delegates discussed load management strategies for the Falkland Islands. Key points included identifying end-user locations, utilising excess heat, implementing energy storage solutions, and designing a robust load management system.

Dispersal of End Users:

Identifying end users' locations and understanding their energy requirements was crucial. The potential for some end-users to benefit from local power sources, such as solar or wind, was discussed. For example, remote farmers might find local independent power sources more favourable than relying on a distant centralised grid.

Energy Storage Solutions:

Various energy storage options, such as batteries, pressurised tanks, and reservoirs, were discussed to help manage demand surges. The importance of protecting these infrastructures or placing them underground to ensure reliability was emphasised.

Demand Management:

The need to prioritise critical sections of the focus area to ensure continuous power supply to essential systems during demand surges was highlighted. Over-designing the load management system to prevent faults in one section from causing catastrophic failures across the entire grid was considered necessary.

Control Room Requirements:

The necessity of having a central control room and a secondary backup control room for increased security and reliability was discussed. Implementing intelligent grid technology for real-time monitoring and management of the energy supply was also highlighted.

Table 6: Load Management	
Challenges	*Solutions*
▪ Transportation of raw materials to the remote islands. ▪ Workforce requirements for new energy infrastructure.	▪ Design modular systems that can be easily transported and assembled. ▪ Establish military training programs to build local expertise.

▪ Dispersion of energy consumers across the islands.	▪ Implement innovative grid technology to manage energy distribution efficiently.

6.5 Table 7: Hydrogen Storage, Transportation, and Conversion to Electricity

Discussions focused on the feasibility of hydrogen storage and transportation, integrating hydrogen with existing renewable energy systems, and hydrogen technology's economic and environmental impacts.

Feasibility of Hydrogen Storage:

The feasibility of various hydrogen storage technologies, including compression and solid-state storage, was discussed. The high cost of fuels and the area's wind and solar potential were seen as favourable for the economics of hydrogen technology. The importance of having storage solutions that are scalable and reliable was highlighted.

Transportation of Hydrogen:

The challenges and solutions for transporting hydrogen within the Falklands were discussed. Within the Falklands, the focus was on moving compressed hydrogen to points of use and using pipelines or transportable receptacles for remote locations. The consensus was that exporting hydrogen from the Falklands was not viable due to the distance from potential importers and the extensive infrastructure required.

Economic and Environmental Impact:

The financial benefits included lower operational costs than importing fuel, while the initial capital expenditure for hydrogen storage and transportation systems was significant. The environmental impact was considered positive, with hydrogen storage and transportation being more sustainable than importing fuels.

Hydrogen Conversion to Electricity:

The efficient conversion of hydrogen into electricity to meet energy demands was discussed. Hydrogen fuel cells were considered the most effective use of hydrogen for electricity, with advancements in hydrogen internal combustion engines also worth consideration.

Table 7: Hydrogen Storage, Transportation & Conversion to Electricity	
Challenges	*Solutions*
▪ Transporting hydrogen safely and efficiently. ▪ Ensuring the safety of hydrogen storage. ▪ Converting hydrogen to electricity effectively.	▪ Develop compression storage systems and solid-state storage solutions. ▪ Utilise advanced safety protocols and materials for hydrogen storage. ▪ Deploy hydrogen fuel cells for reliable electricity conversion.

6.6 Table 8: Carbon Capture and Storage

Delegates examined carbon capture and storage technologies' economic viability, environmental benefits, and potential drawbacks.

Challenges and Solutions:

The high initial costs of carbon capture technology and the need for regulatory compliance were vital challenges. Solutions included investing in research and development and securing government support. Detailed feasibility studies and pilot projects were recommended to understand these technologies' economic and environmental impact.

Economic and Environmental Impact:

The financial benefits included potential job creation and reduced reliance on imported fuels, while the costs involved significant initial investment in infrastructure and technology. The environmental benefits included reduced carbon emissions and improved air quality, contributing to sustainability goals.

Table 8: Carbon Capture & Storage	
Challenges	*Solutions*
▪ Integrating carbon capture technology with existing infrastructure. ▪ Assessing the environmental impact of carbon capture processes. ▪ Evaluating the economic feasibility of carbon capture and storage.	▪ Develop and deploy advanced carbon capture technologies. ▪ Integrate carbon capture with hydrogen production processes. ▪ Conduct comprehensive economic analyses to ensure feasibility.

6.7 Table 9: Synthetic Fuel Production

Delegates discussed synthetic fuel production, particularly for aviation. The high energy requirements for producing synthetic fuels and the current limitations of sustainable energy setups were highlighted.

Production of Synthetic Fuels:

The potential of leveraging excess renewable energy for synthetic fuel production was discussed. Integrating synthetic fuel production with existing hydrogen infrastructure was essential for maximising efficiency. The need for detailed feasibility studies to understand synthetic fuel production's economic and environmental impact was emphasised.

Economic and Environmental Impact:

The financial benefits included potential job creation and reduced reliance on imported fuels, while the costs involved significant initial investment in infrastructure and technology. The environmental benefits included reduced carbon emissions and improved air quality. The role of synthetic fuels in enhancing military resilience was also discussed.

Table 9: Synthetic Fuel Production	
Challenges	*Solutions*
▪ Developing infrastructure for renewable energy to support synthetic fuel production. ▪ Ensuring the energy density of synthetic fuels meets military requirements. ▪ Integrating synthetic fuel production with existing energy systems.	▪ Expand renewable energy infrastructure to support synthetic fuel production. ▪ Develop high-energy-density synthetic fuels for military applications. ▪ Integrate synthetic fuel production with hydrogen and renewable energy systems.

6.8 Table 10: Fuel Cells

Delegates focused on the feasibility and implementation of fuel cells for various applications. Discussions included integrating fuel cells with existing energy systems, the economic benefits, and the environmental impacts.

Feasibility and Integration:

The feasibility of fuel cells was considered promising, with technological advancements making them competitive with traditional energy sources. Integrating fuel cells with existing infrastructure was seen as essential for seamless operation. The potential for using fuel cells in various applications, including transportation and stationary power generation, was discussed.

Economic and Environmental Impact:

The financial benefits included reduced fuel costs and potential job creation. The environmental impact was positive, with reduced carbon emissions and improved air quality. The need for training and skills development to operate and maintain fuel cells was also highlighted.

Table 10: Fuel Cells	
Challenges	*Solutions*
▪ Ensuring a reliable supply chain for fuel cell components. ▪ Addressing storage and transportation issues for hydrogen. ▪ Maintaining and servicing fuel cell systems.	▪ Develop local hydrogen generation capabilities to ensure a steady supply. ▪ Integrate renewable energy sources with fuel cell systems. ▪ Establish robust maintenance and servicing protocols for fuel cells.

6.9 Table 11: Scheme Financing, Management and Construction

The focus was securing funding and policy support, ensuring regulatory compliance, and providing financial incentives for businesses and individuals to adopt hydrogen technology.

Funding and Policy Support:

Securing government grants and subsidies to support hydrogen projects was emphasised. Attracting private investors interested in renewable energy and hydrogen technology was also discussed. The role of public-private partnerships in leveraging resources and sharing risks was considered crucial.

Regulatory Compliance:

Ensuring all hydrogen technologies and infrastructure comply with local and international regulations was highlighted as essential for safety and standardisation. The need for financial incentives to encourage businesses and individuals to adopt hydrogen technology was also discussed.

Economic and Environmental Impact:

The financial benefits included potential job creation and reduced reliance on imported fuels, while the costs involved significant initial investment in infrastructure and technology. The environmental benefits included reduced carbon emissions and improved air quality, contributing to sustainability goals.

Table 11: Scheme Financing, Management & Construction	
Challenges	*Solutions*
▪ Securing funding for large-scale hydrogen infrastructure projects. ▪ Ensuring the economic feasibility of proposed projects. ▪ Engaging stakeholders and gaining their support.	▪ Develop public-private partnership (PPP) models to secure funding. ▪ Adapt mutual investment models (MIM) and non-profit distribution (NPD) models for project financing. ▪ Engage academic institutions and research organisations for additional funding and support.

7. SUMMATIVE ASSESSMENT OF THE DISCUSSIONS

Feasibility and Implementation:

The primary challenges identified in the feasibility and implementation of hydrogen technology include acquiring environmental permits, navigating geopolitical conflicts, and building the necessary infrastructure for hydrogen production, transport and storage. Another significant challenge is transitioning from diesel to hydrogen for the local population and industries. Potential solutions involve early engagement with regional and international environmental bodies, collaboration with the local government and international organisations to address geopolitical concerns and developing phased infrastructure plans starting with smaller-scale projects to build confidence and expertise. Educational campaigns and incentives are essential to promote the benefits of hydrogen over diesel.

Integration and Synergy:

Developing microgrids that incorporate various renewable sources and energy storage systems to balance supply and demand is crucial. This could be utilising stored hydrogen as a readily available energy source to top up renewable energy supply to assure a steady and adequate energy supply meeting the demand. This is central to operations in winter months when energy demand significantly increases for heating to keep warm while solar energy generation substantially decreases because of reduced daylight hours.

Economic Impact:

Developing and maintaining renewable energy infrastructure can create local jobs in renewable energy, hydrogen production, and related industries, diversify the local economy and stimulate growth through new industries, and reduce vulnerability to fuel price fluctuations through reduced expenditure on imported fuels and lower energy costs. However, the initial infrastructure, technology, and training investment poses a significant cost challenge.

Environmental Impact:

The environmental benefits of hydrogen technology include the reduction of carbon emissions, improved air quality, and the potential use of by-product water. Potential drawbacks involve ecological effects from wind and tidal power installations and the large footprint required for solar installations. Implementing robust environmental monitoring and mitigation strategies is essential to meet sustainability targets and reduce the carbon footprint. Ecosystem preservation can be achieved by implementing hydrogen technology harmoniously with local ecosystems. Reduce the carbon footprint by lowering greenhouse gas emissions by replacing fossil fuels with hydrogen. Air quality improvements can be made by reducing air pollution from diesel generators and other fossil fuel sources.

Community and Stakeholder Engagement:

Engaging the local community and stakeholders is vital for successfully implementing hydrogen technology. This includes education and outreach to inform the community about the benefits of hydrogen and renewable energy, and to address concerns on hydrogen safety. It should be engaging local businesses, government, and community groups in planning and decision-making processes, and providing financial incentives and support programs to encourage adoption of hydrogen technology.

Suitably Qualified and Experienced Personnel:

The successful implementation of hydrogen technology requires training and skills development for the local workforce. Collaboration with educational institutions to develop training programs and leveraging existing resources, such as the MOD, to provide training and expertise is crucial. Among others, engineering, maintenance, environmental management, and safety protocols are essential skills for hydrogen adoption.

Collaborative Partnerships:

Fostering collaborations between universities and industry for research and innovation, partnering with defence contractors to integrate hydrogen technology into military applications, and engaging with international environmental and energy organisations for additional resources and expertise are essential strategies for advancing hydrogen technology and its applications. Examples of successful collaborations, among others,

- VW's SAF Plant in Chile: Collaboration between VW and local partners for sustainable aviation fuel production.
- Toyota Mirai: Hydrogen vehicle trial by the Royal Navy at Devonport.

Funding and Investment:

Government support in the form of funding and policy support from the UK government and international organisations is necessary to advance hydrogen initiatives. Ensuring all hydrogen technologies and infrastructure comply with local and global regulations is critical for safety and standardisation. Providing financial incentives for businesses and individuals to adopt hydrogen technology will encourage widespread adoption and support the growth of the hydrogen economy.

- Provide government grants and subsidies to support hydrogen projects.
- Attract private investors interested in renewable energy and hydrogen technology – Public-Private Partnerships (PPPs) to leverage resources and share risks.

Road Map:

The road map to delivering hydrogen technology involves conducting detailed feasibility studies to assess economic and environmental viability, planning and building necessary hydrogen production and distribution infrastructure, and starting with small-scale pilot projects to test and refine technologies. Continuous community engagement and scaling up projects based on pilot results and community feedback are essential. Robust monitoring systems are required to track progress and adjust strategies as needed.

8. NEXT STEPS

Conducting feasibility studies, initiating pilot projects, and engaging stakeholders are short-term plans necessary to advance hydrogen initiatives. These steps will provide the foundational understanding and initial practical experiences required to move forward effectively. Continuing stakeholder engagement, monitoring pilot project outcomes are essential follow-up actions. By maintaining open communication with stakeholders and assessing the results of pilot projects, we can refine our approaches to improve effectiveness.

The long-term plans include developing large-scale hydrogen infrastructure, integrating it with renewable energy systems, and securing funding. These actions will ensure sustainable growth and scalability of hydrogen technology, making it a viable and significant part of the energy landscape. Implementing robust monitoring systems to track progress and adjust strategies as needed is crucial for the ongoing success of hydrogen initiatives. These systems will provide the data and insights necessary to make informed decisions and ensure the projects remain on track towards their goals.

Table 1 shows the top three potential challenges to the long-term plans together with their mitigations. Table 2 shows the top three actions with their rationales for short-term and long-term, respectively.

Table 1: Top Three Potential Challenges and Their Mitigations.

Challenges	Mitigations
High Initial Investment	Secure funding from multiple sources and provide financial incentives
Infrastructure Development	Plan and phase infrastructure projects to manage costs and risks
Regulatory Barriers	Work closely with regulatory bodies to ensure compliance and streamline approval processes

Table 2: Short-term and long-term plans.

Time Frame	Actions	Rationales
Short-Term	Upgrade existing renewable energy infrastructure, including wind and solar farms.	Increasing the number of wind turbines and solar panels is crucial for expanding renewable energy sources and will support hydrogen production from renewable sources.
	Conduct feasibility studies and pilot projects to test hydrogen production and storage technologies.	Investing in research and development for advanced hydrogen technologies will drive innovation and improve the efficiency and cost-effectiveness of hydrogen solutions.
	Implement modular systems for hydrogen production and distribution.	
Long-Term	Developing large-scale electrolysis facilities for hydrogen production	This is essential for establishing a robust hydrogen economy
	Establishing a comprehensive hydrogen storage and distribution network	This will ensure that hydrogen can be efficiently and reliably delivered where needed. This is vital to facilitate the widespread use of hydrogen.
	Integrating hydrogen technology with existing energy systems and infrastructure	This will further enhance its utility and effectiveness, making it a seamless addition to current energy solutions.

9. CONCLUSIONS

This conference successfully united experts from industry, academia, and the military to explore the potential of hydrogen technology and renewable energy sources to transform the Falkland Islands. The primary goal was to reducing reliance on fossil fuels, and enhancing energy security to meet net-zero emission targets by adopting sustainable energy solutions,

It highlighted the feasibility of integrating hydrogen technology into the Falklands' energy system and the benefits of hydrogen as a clean, versatile energy source. It emphasised the need for stakeholder collaboration to leverage local renewable energy resources, such as wind and solar, to produce green hydrogen. This hydrogen can power military operations, support local industry, and improve sustainability.

Global advancements in hydrogen technology, including improved electrolysis and storage solutions, coupled with the Falklands' renewable energy potential, position the region to lead in hydrogen adoption and innovation.

Immediate recommended actions include conducting feasibility studies, initiating pilot projects, and engaging stakeholders to lay the groundwork for larger-scale hydrogen infrastructure. Long-term plans involve developing electrolysis facilities, hydrogen storage and transport networks, and integrating hydrogen technology with existing energy systems. These efforts will require significant investment, robust regulatory frameworks, and ongoing stakeholder engagement.

The transformation promises environmental benefits, such as reduced carbon emissions and improved air quality, alongside economic advantages, including cost savings on imported fuels, job creation, and economic diversification. Success hinges on securing funding, fostering public-private partnerships, and ensuring regulatory compliance.

In summary, the MOD, Team Defence Supported, Hydrogen Conference underscored the significant potential of hydrogen technology to revolutionise the Falkland Islands' energy landscape. The collaborative efforts initiated at the conference set a clear path to achieving net-zero emissions and enhancing the region's economic resilience through innovative hydrogen solutions.

Appendix A – Themed Table Delegate Arrangement

Table Number	Table Theme	Delegates
2	Renewable Power Generation	Wastewater Fuels, Beam, Amazon Web Services, Royal Navy, University of Exeter, British Geological Survey, and Rolls-Royce
3	CHP Engines	Wastewater Fuels, 2G Energy Ltd, RAF, Babcock, DE&S, SPHERA, Beam, and Yellow Power Ltd
4	Electrolysers & the Water Cycle	Wastewater Fuels, ITM Power, Enapter, Costain, Frazer-Nash Consultancy, Severn Trent Services, and UKStratCom
5	Electrolysers & the Water Cycle	Wastewater Fuels, BP, British Army, University of Southampton, University of Exeter, and Toyota
6	Load Management	Wastewater Fuels, French Operational Energy Service (Service de l'énergie opérationnelle), National Grid, Ansys, TFD Europe, and UKStratCom
7	Hydrogen Storage, Transportation & Conversion to Electricity	Wastewater Fuels, UKStratCom, Ryze, BAK Motors UK, Hydrogen UK, MTC, Geopura, and Exolum
8	Carbon Capture & Storage	Wastewater Fuels, Babcock, Futures Lab, London Tech Bridge, Parallel Carbon, Mott MacDonald, and Protium
9	Synthetic Fuel Production	Wastewater Fuels, Dstl, Rheinmetall, BMT, Greenlyte Carbon, and Osprey Consultancy Services
10	Fuel Cells	Wastewater Fuels, Royal Navy, Drive System Design, and WMG
11	Scheme Financing, Management & Construction	Wastewater Fuels, DIO, Deloitte, KBR, QinetiQ, DE&S, and Schneider Electric

Appendix B – Current State of Hydrogen Technology

Hydrogen is increasingly recognised as a versatile and clean energy carrier that can be crucial in transitioning to renewable energy systems. It can be produced through various methods, including renewable electricity electrolysis. It can be used in fuel cells to generate electricity or as a fuel for vehicles and industrial processes.

Globally, significant advancements have been made in hydrogen technology. Key developments include:

- Improved efficiency and scalability of electrolysers.
- Advances in hydrogen storage and transportation technologies.
- Integration of hydrogen with renewable energy systems for a stable and reliable energy supply.
- Development of hydrogen fuel cells for various applications, including transportation and power generation.

Hydrogen offers several benefits, including:

- Zero emissions when produced from renewable sources.
- High gravimetric energy density (120 MJ/kgH_2), making it an efficient and lightweight energy carrier.
- Versatility in various applications, from transportation to industrial processes.
- A feedstock for other energy vectors, such as methanol, ammonia, methane and synthetic fuel.
- Existing infrastructure (gas transport and gas storage) can be repurposed for hydrogen.

However, challenges remain, such as:

- High production costs, especially for green hydrogen.
- Infrastructure requirements for storage, transportation, and distribution.
- Technological and regulatory barriers.
- Public perception and acceptance.
- Low volumetric energy density, making it challenging to store it in compact form.

Appendix C – The Falkland Islands

The Falkland Islands, located in the South Atlantic Ocean, a remote and sparsely populated British overseas territory. The economy is primarily driven by fishing, agriculture, and tourism, with a substantial military presence due to the strategic location. Unique ecosystems and a fragile climate characterise the local environment, necessitating sustainable development practices.

The Falkland Islands consist of East Falkland, West Falkland, and numerous smaller islands. The British Forces maintain a significant presence on the islands, including RAF Mount Pleasant, the main military base approximately 33 miles from the capital, Stanley. The base is powered by three wind turbines from the Mare Harbour wind farm. Additionally, two remote military sites, Mount Alice and Byron Heights, are likely powered by diesel generators.

Annually, operations in the Falklands consume approximately 41,500 cubic meters of aviation fuel and 40,300 cubic meters of diesel, resupplied one to two times a year. The logistics of resupplying fuels are challenging due to the Falklands' distance of about 8,000 miles from the UK.

In a business-as-usual scenario, Defence is expected to continue maintaining its presence on the Falklands, procuring the latest standard of fuels from the open market. However, this approach risks missing the net-zero target by 2050 due to limited supply of sustainable fuels from non-fossil fuel sources.

The most desirable scenario for operations in the Falklands targets net-zero greenhouse gas emissions and energy self-sufficiency. Achieving net-zero emissions aligns with the Government's climate change commitments, while energy self-sufficiency eliminates the need for fuel resupplies, reducing logistical burdens, costs, and associated emissions.

References:

- Green Islands (globalislands.net)

Appendix D – Environmental and Infrastructure Challenges on the Falkland Islands

The Falkland Islands face significant environmental challenges, primarily water scarcity, as they receive roughly half of the rainfall in the UK (Annual rainfall is about 573.6 mm and 1162.9 mm for the Falklands and the UK, respectively). The existing sewage system needs to be revised, as it was designed for a much smaller population. The base is predominantly tarmacked, with limited road infrastructure; there is only one tarmac road from Stanley to Mount Pleasant, with other roads being gravel or mud tracks, complicating transportation.

The average energy demand at Mount Pleasant is between 3 and 5.5 MW. The infrastructure, built in the 1980s, needs to be better insulated. Half of the site is heated via a diesel-fuel boiler connected to a district heating system, while the other half relies on old electric heaters. Family quarters use aviation fuel for boilers.

The Main Power Station, built in the 1980s, includes five 1.2 MW F76 marine diesel generators, consuming 0.26 L/kWh of fuel. The Standby Power Station hosts three similar generators. The New Main Power Station, set to become operational soon, features five 2 MW F76 marine diesel generators with a 20% fuel efficiency improvement. Additionally, a new Auxiliary Power Station will include three smaller generators using F54 automotive diesel. Renewable energy efforts include three wind turbines, although one is currently non-operational. When all three are functional, they provide 5% of the annual energy needs, which could increase to 10% with battery integration.

The British Forces at Mount Pleasant Complex are committed to enhancing sustainability and energy efficiency, addressing infrastructure challenges, and working towards ambitious environmental goals. With strategic initiatives and innovative solutions, they aim to improve operational resilience and reduce their ecological footprint.

Despite the potential for renewable energy, the Falkland Islands still need to catch up on opportunities to harness these resources. According to recent surveys, the Falkland Islands rely predominantly on diesel generators for electricity, leading to high fuel costs and environmental degradation. The transition to renewable energy sources, such as wind and solar, has been slow, leaving significant room for improvement.

References:

- Green Islands (globalislands.net)
- Falkland Islands Energy Strategy (falklands.gov.fk)

Appendix E – Future Initiatives on the Falkland Islands

Several initiatives are underway or being explored to enhance sustainability and energy efficiency. There are plans to leverage technological advancements in Wastewater Fuels to address these issues, potentially alleviating the water crisis and providing renewable fuel. Recycling efforts include returning materials like metal, and plastic to the UK, and with plans for a diesel-powered incinerator in Stanley. There are joint projects to develop hydronics and hydroponics, improving agricultural viability. Interest in renewable heating solutions and expanding the electric vehicle fleet, with potential exploration of hydrogen vehicles, is also evident. To address water scarcity, retrofitting roofs for rainwater harvesting and creating a circular water economy are being considered. With four new wind farms planned, feasibility studies for battery integration suggest renewable energy could achieve 80-90% of the demand. Energy storage innovations, such as intelligent energy battery storage and heat batteries, are being explored, particularly for winter heating needs.

Efforts are being made to reduce reliance on ocean-going tankers, currently required twice annually, each making a 16,000-mile round trip and burning 10 million litres of fuel, costing £1 million to hire the tanker and £6-7 million per fuel load. Exploring synthetic aircraft fuel production is another area of interest, with the potential to become a hub for renewable energy.

The vision is to achieve net-zero emissions by 2040, excluding aviation fuel. Efforts focus on generating renewable energy, improving water management, and enhancing infrastructure resilience. Cleaner water and healthier livestock would benefit civilian farmers.

References:

- Falkland Islands Environment strategy 2021-2040 (ukota.org)
- Keeping Warm and Green: Sustainable Heating Solutions for the Falkland Islands - Falkland Business Spectrum (falklandislandschamberofcommerce.com)
- Mapping Renewable Energy | (ukfit.org)

Appendix F – Assumptions for The Falkland Islands Net Zero and Self-Sufficient (NZSS) Scenario

This scenario focuses exclusively on military staff and operations at the Mount Pleasant Complex (MPC) on the Falkland Islands, excluding the civilian population. The base houses 800 military personnel and 1,200 contractors and civilians. The following expectations are assumed:

- Diesel generators at mountain military sites are replaced with emission-free hydrogen power units (HPUs) using fuel cell technology and green hydrogen produced at MPC.
- Additional wind turbines at Mare Harbour wind farm and other sites to support electric vehicle charging, hydrogen generation, synthetic fuel production, carbon capture, and water processing at MPC.
- Electrolysers at MPC produce green hydrogen from green electricity provided by the Mare Harbour wind farm and other sites. This hydrogen fuels HPUs and serves as feedstock for synthetic fuel production.
- A water processing facility at MPC processes seawater to provide high purity water feedstock for the electrolysers, which is powered by green electricity.
- At MPC, a synthetic fuel production plant produces synthetic aviation fuel and diesel using green electricity.
- A carbon capture facility at MPC provides carbon dioxide feedstock for synthetic fuel production powered by green electricity.
- All vehicles are electric-powered, with on-site charging stations powered by green wind farm electricity and HPUs at remote sites.
- Synthetic aviation fuel and diesel are used for RAF aircraft and RN ships, respectively.
- HPUs supplement green electricity generation when wind conditions are unfavourable.
- Sustainable energy technologies and systems are operated and maintained by suitably skilled personnel, with Defence providing appropriate training.

Implementing the NZSS scenario requires significant investment in infrastructure and technology in collaboration with the Falklands government. The upfront investment is essential, but once operational, the system has the potential to reduce through-life and logistical supply costs. The implementation faces barriers and challenges, necessitating time to secure funding, build infrastructure, and train personnel.

High engagement and cooperation with the Falklands government are crucial for extensive infrastructure development. Early stakeholder engagement and securing buy-in from decision-makers are essential. Collaboration with original equipment manufacturers ensures that equipment reaches the appropriate technology readiness for trials and deployment.

To achieve these targets, MPC and other military sites will require comprehensive upgrades. The Falkland Islands' unique position offers high renewable energy potential per capita, significantly greater potential than other regions globally. Combining green hydrogen, wind power, and synthetic fuels can transform the energy landscape, aligning with the UK Government's broader climate goals.

Appendix G – Presentation Pack

The presentation pack for the conference is too big to be attached with this document. It is available upon request.

For MOD personnel, please send your request to Lam, Joseph C1 (UKStratCom-DefSp-OEA GasTechMgr).

For others, please send your request to Darin Tudor of Team Defence Information.

Appendix H – Photographs from the Conference

General scene from the conference.

StratCom speaker: Flt Lt Richard Griffiths.

Electrolyser Innovator and Wastewater Fuels speaker, Dr. Daniel Carlotta-Jones.

Table 8 discussing Carbon Capture and Storage.

Table 3 discussing CHP Engines.

Table 9 discussing Synthetic Fuel Production with zero-alcohol mojitos.