Northfleet HPF EP Application

Climate Change Adaptation Risk Assessment

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Contents

1. Introduction

1.1 Background

HYRO Limited (" HYRO") is a company that provides green hydrogen solutions for energy intensive businesses, supporting hard-to-electrify processes to reach their decarbonisation goals. HYRO is a joint venture between Octopus Energy Generation and RES. RES is the world's largest independent renewable energy developer having delivered 23GW of generation in 11 countries. Octopus Energy Generation is one of Europe's largest investors in renewable energy. The team manages over 3GW of green power assets worth £5bn across 11 countries.

HYRO proposes to install a green hydrogen production facility (HPF) on land next to Kimberley-Clark's Northfleet Paper Mill in Northfleet, Kent. The HPF would be developed on land owned by Kimberley-Clark (KC) in a vacant part of their site currently given over to hardstanding.

HYRO will develop a 15 megawatt (electrical) electrolytic hydrogen plant with ancillary gas handling, compression, odourisation and purification and storage plant which will send hydrogen by a pipe run to the paper mill's boiler plant at the southern end of the site. The pipe run will be entirely within the KC site boundary.

This Climate Change Adaptation Risk Assessment (CCARA) will be integrated into the Environmental Management System (EMS) for the site as it is developed ahead of commissioning. The EMS is currently under development.

1.2 Requirement for a Climate Change Adaptation Risk Assessment

Environmental Permits (EP) granted in England and regulated by the Environment Agency (EA) require a written EMS (Environment Agency, 2016). An EMS is a set of procedures describing what will be done to minimise the risk of pollution from activities covered in an EP.

As of April 2023, the EA has issued new guidance which requires if the EP was issued:

- On or after 1st April 2023, climate change adaptation planning must be integrated into the EMS; or
- Before April 2023, whilst the EMS should already consider climate impacts, a climate change adaptation risk assessment must be completed by 1st April 2024.

HYRO's EMS is still under development at the time of the application and will be fully complete and implemented ahead of commissioning. The procedural outcomes of this CCARA will be integrated into the EMS. This document hence demonstrates that the risk assessment has been carried out and identifies measures to be included in site operational procedures as the EMS emerges.

1.3 Site Description

The Site is in Northfleet, approximately 500m north from the centre of Northfleet. The Site is currently a hardstanding at the Kimberley-Clark's Northfleet Paper Mill comprising an area of approximately 4 hectares (ha). The Papermill lies adjacent to the south of the site shown in the drawing in **Figure 1 (main application pack)**. The River Thames lies directly north of the site. Sawyer's Lake lies c1km to the south of the site.

Surface water drainage at the site will not change as a result of the permitted activity.

1.4 A Changing Climate

UK climate change projections (Met Office, 2023) indicate that the UK in general can expect the following impacts:

- **Increased average temperatures** (especially during summer and winter);

- **More heat waves and hot days** (increased frequency and intensity);
- **Rising sea levels** (posing a threat to coastal areas);
- **Changes in rainfall patterns and intensity** (leading to alterations in precipitation distribution); and
- **Increased storm activity** (increased frequency and severity).

Considering the possibility of a changing climate affecting operations, potential impacts on the ability of HYRO to comply with their EP are considered. In a broader sense, these factors can significantly impact businesses including their supply chains, consumers and markets. Planning for these impacts will enable HYRO to:

- **Ensure Compliance**: by incorporating climate change considerations into the EMS, HYRO can effectively adhere to EP obligations and regulations;
- **Environmental Impact Reduction**: proactive planning allows minimisation of environmental footprint during extreme weather events and mitigate the potential impact of these events on operations, including the prevention of hydrogen gas release or other abnormal operation that could result in emissions); and
- **Enhance Resilience and Business Continuity**: strategic planning helps build resilience and maintain uninterrupted business operations. By anticipating climate-related risks, HYRO can avoid unplanned start-ups, shutdowns and other operational disruptions.

By addressing the impacts above, the intention is that HYRO can better navigate the challenges posed by a changing climate and maintain their environmental stewardship while ensuring the continuity of operations.

2. Methodology

The EA recommend the process for integrating climate change adaptation into an EMS under an EP be completed using the following six stages (Environment Agency, 2023):

- **1. Preparation**;
- **2. Find Potential Impacts**;
- **3. Complete Risk Assessment**;
- **4. Find Control Measures**;
- **5. Write Climate Change Adaptation Plan**; and
- **6. Monitor, Record and Review Plan**.

The methodology is applied in **Section 3**.

3. Climate Change Adaptation Risk Assessment

3.1 Preparation

Climate risk management measures are a work in progress as the HYRO EMS is under development and the detailed design of the Installation is still underway. Measures to manage risks associated with climate change are identified as part of this assessment.

The final EMS will be reviewed and approved by the senior management team at HYRO, and clear roles and responsibilities defined for the implementation of the EMS and climate risk-specific measures therein. The

EMS will be a key document in managing the day-to-day operations of the HYRO Installation, and the senior management team will ensure a high level of familiarity and engagement for staff.

In terms of size and complexity, the Installation does not require an extensive risk assessment. However, a team including at least one person holding a senior position will be responsible for ensuring compliance with the mitigation measures outlined in this document and its periodic review.

3.2 Potential Impacts

Using the climate change risk assessment examples provided by the EA (Environment Agency, 2021), the following possible impacts have been considered. All data discussed in this section are based on this EA document.

3.2.1 Summer Daily Maximum Temperature

According to the EA, summer daily maximum temperatures may see a rise of approximately 7°C above current average summer temperatures. There is a growing possibility of experiencing extreme temperatures exceeding 40 °C more frequently.

3.2.2 Winter Daily Temperature

Daily winter temperatures may translate to a 4°C change in either direction from the current average, bringing the potential for experiencing more extreme temperatures, both warmer and colder than currently encountered.

3.2.3 Daily Extreme Rainfall

Daily rainfall intensity may increase by up to 20%.

3.2.4 Average Winter Rainfall

Average winter rainfall is projected to rise by more than 40% compared to today's averages.

3.2.5 Sea Level Rise

Sea levels could potentially rise by as much as 0.6 metres compared to their current level.

3.2.6 Drier Summers

Summers may experience a potential reduction of up to 40% in rainfall compared to current levels.

3.2.7 River Flow

At their peak, watercourse flow could increase by 50% compared to current levels, while at its lowest, it could decrease by 80%.

3.2.8 Storms

Storms are likely to undergo changes in both frequency and intensity. The distinctive combination of heightened wind speeds, increased rainfall, and lightning during these events indicates the potential for more severe storm impacts.

3.3 Climate Change Adaptation Risk Assessment

This section takes consideration of the climate changes identified above and investigates potential impacts on the Installation without mitigation.

3.3.1 Summer Daily Maximum Temperature

The rise in summer daily maximum temperatures can have various significant impacts on different aspects. Firstly, it may cause the expansion and stress of plant, pipework and fittings. Additionally, there could be a risk of an increase in dust emissions if housekeeping measures do not prevent mud from being tracked onto

and around the site, in water consumption for domestic type uses and issues with heat rejection from the electrolyser cooling water circuit.

The production processes already generate heat, and higher ambient temperatures can put significant pressure on cooling systems. Consideration is also required for hydrogen storage to avoid overheating of storage tanks. Monitoring equipment needs to be resilient to the potentially increased ambient temperature.

There will be possible impacts on employees and productivity through increased heat stress and tasks requiring personal protective equipment (PPE) may cause discomfort over long periods.

Furthermore, there is an increased risk of problems arising from severe heat or exposure to ultraviolet radiation. This could affect infrastructure, causing expansion issues with metallic elements like building structures, as well as rapid degradation of materials such as rubber and plastics, or even failure of plastic compressed air hoses.

The higher temperatures also bring an increased risk of wildfires in other areas, with limited assistance available from the Fire Service if they consider it lower priority due to other simultaneous demands on their resources, which in turn poses a risk of fire spreading and affecting or limiting normal Installation operation.

3.3.2 Winter Daily Temperatures

In times of extreme cold weather, several challenges arise. The failure of heating systems and the freezing of water may lead to blockages, especially on lengthy pipelines and exposed storage areas, potentially resulting in process failures. Additionally, extreme winter temperatures increase the risk of pipework ruptures, potentially impacting process water and effluent systems, thereby causing interruptions to normal operation. The situation can be further exacerbated by frozen on-Site roadways, which can hinder access for both staff and emergency vehicles. Moreover, prolonged periods of ice or snow-loading have the potential to cause damage to the Installation's infrastructure through increased mechanical load on flat surfaces and freeze-thaw damage.

3.3.3 Daily Extreme Rainfall

Flooding, because of extreme rainfall, poses significant risks, including the potential for increased surface water on Site and flash flooding. It can also trigger power failures, disrupt processes, and cause infrastructure damage. Furthermore, flooding may restrict access and egress for both staff and emergency services due to the inundation of the Site which may further disrupt operations. Figure 3-1 shows flood risk from surface water.

Figure 3-1 Flood Risk from Surface Water

3.3.4 Average Winter Rainfall

Changes in wintertime rainfall weather patterns can lead to overland flow or groundwater flooding, potentially overwhelming drainage systems and interceptors. The on-Site flooding that ensues could result in power failures, process disruptions, and infrastructure damage. Moreover, limited access or egress for staff and emergency services may occur due to the inundation of the Site.

3.3.5 Sea Level Rise

The Site faces the estuarine Thames and may be vulnerable to future sea level rises.

3.3.6 Drier Summers

Drought restrictions on both direct and indirect abstraction can impact the availability and quality of incoming water. Additionally, the lower ambient moisture levels can pose an elevated risk of fire.

3.3.7 River Flow

Increases in the flow of the nearby River Thames could be unprecedented and result in significant flood damage. This heightened flow also poses a risk of water course levels becoming too high, leading to difficulties in discharge and causing drainage backups on the Site, potentially causing localised flooding. Reduced flow in watercourses might have adverse effects on the quality of abstracted water though this will be a matter for the utility provider in the first place. Figure 3-2 shows flood risk from the River Thames.

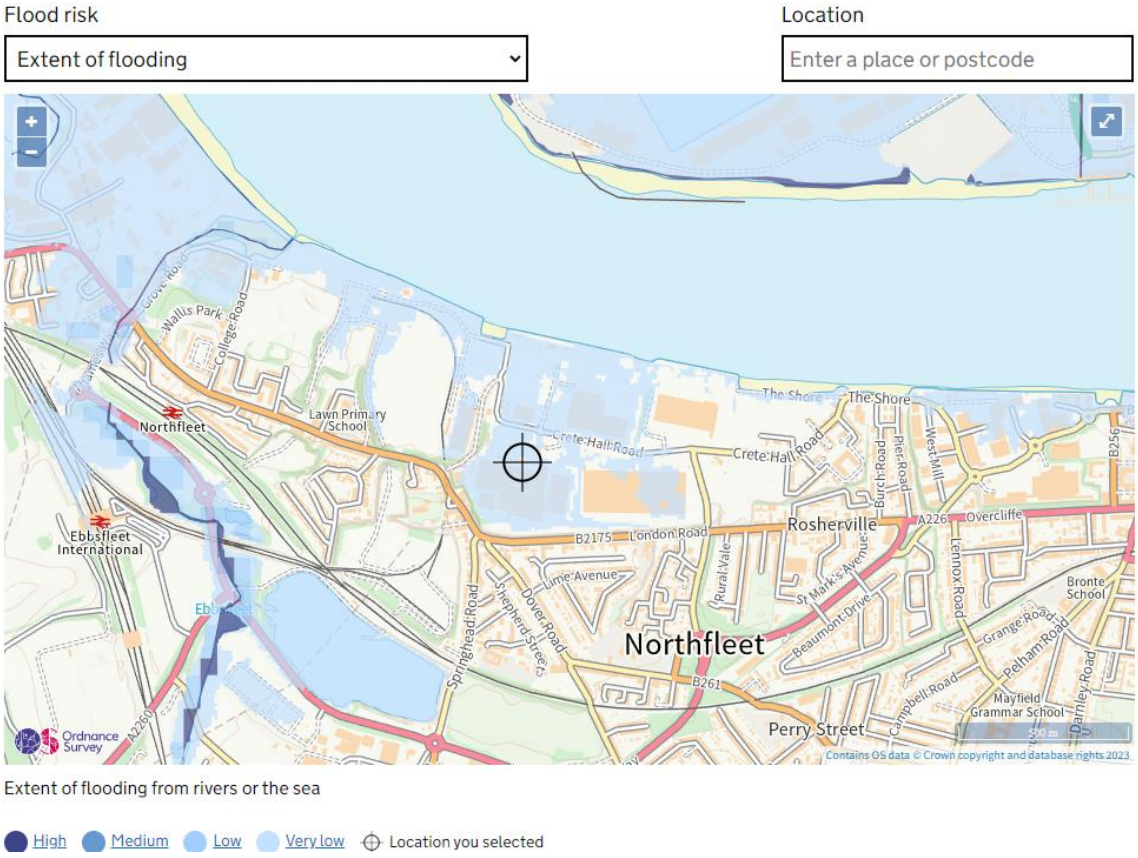

Figure 3-2 Flood Risk from Rivers or Sea

3.3.8 Storms

Storms and high winds can cause damage to infrastructure and building fabric. This damage has the potential to disrupt normal operations.

3.4 Control Measures

As outlined in **section 3.3**, the Installation is at risk from a changing climate, therefore, various mitigation strategies which HYRO will follow are detailed below:

3.4.1 Summer Daily Maximum Temperature

- Regular inspections and preventative maintenance of the Installation, coupled with stringent process monitoring (e.g., temperature sensors on critical apparatus);

- Adequate expansion provisions will be in place for materials susceptible to heat-induced expansion, particularly metals;
- For external materials with high sun exposure, materials prone to heat- and photodegradation will be avoided at the design stage. External storage tanks and containers with tanks within will generally be painted white to minimise solar gain as a matter of course.
- To mitigate against pests and flies, regular cleaning of foul and storm water drains, and pipe work, as part of general housekeeping maintenance, will be carried out;
- HYRO will ensure staff welfare during higher temperature working conditions by providing suitable personal protective equipment (PPE) and reviewing shift working patterns to minimize heat-related risks;
- An emergency fire management procedure to be employed in the event of local wildfires will be developed and the advice of the local fire service sought.

3.4.2 Winter Daily Temperatures

- insulation on Pipework containing water will be insulated. Operating procedures will be reviewed to ensure that pipework is not left full of static water when not in use, and potential dead-legs, where static water may accumulate, will be identified and designed out where possible. Equipment will be drained when not in use, though this is expected to be limited to infrequent major maintenance overhaul periods. Regular inspections and maintenance of insulation, especially on pipework and equipment in exposed areas of the Installation, will be carried out via periodic CCTV surveys;
- There is minimal piped water other than the mains supply which will be suitably insulated to prevent freezing. Areas prone to increased icing and snow loading will be identified during detailed design. Snow loading calculations will be reviewed, and reinforcement will be provided if necessary to maintain building integrity to withstand heavy snow. The structures used for most of the Installation's equipment will be extremely robust and expected to easily withstand virtually any realistic snow load;
- Given that this project is still in the design stage, engineering design for all infrastructure and equipment will be planned to allow tolerances for very low temperatures and rapidly changing weather conditions; and
- To ensure safe access and egress on the Site for both staff and emergency services during winter, regular inspections and maintenance of roadways will be performed, grit will be made available to treat road surfaces. Equipment and materials for clearing snow and ice will also be readily accessible.

3.4.3 Daily Extreme Rainfall

- Sensitive equipment will be raised to limit the impact of any ponded surface water.
- Surface water attenuation at the site is subject to requirements to attenuate for the 30-year storm event plus 35% climate chafe with a surcharged outfall at the 1 in 200-year tidal storm event level.
- Regular testing of the surface water drainage systems will be conducted;
- Emergency pumps will be made available to swiftly remove flood water and the safest location to discharge floodwater will be determined;
- Control and electrical systems will be situated above a reasonable flood level based on the results of the Flood Risk Assessment as set out in the floor risk assessment (FRA);
- Chemicals will be securely stored, generally on pallet bunds which will provide clearance above a reasonable flood level;
- HYRO will sign up to the EA flood warning system;

- Areas prone to water pooling are not expected but any that emerge will be identified to establish alternative transport routes to and from the Site in case of reduced access or egress;
- Good housekeeping practice involving clearing gutters of debris, removing moss from roofs, and replacing guttering with larger diameters when necessary; and
- After a period of heavy rainfall, any damage will be reviewed and assessed, and repairs will be carried out to maintain the structural integrity of systems in place.

3.4.4 Average Winter Rainfall

An increased average winter rainfall will see the potential for increase Site surface water and flooding. The same mitigation strategies summarised in **section 3.4.3** (Daily Extreme Rainfall) apply to this section as well.

3.4.5 Sea Level Rise

The Installation is not located near the coast, therefore mitigation strategies for sea level rise will not be implemented by HYRO. The main source of flood risk at the site is likely to be tidal flooding associated with overtopping or a breach in the defences on the River Thames.

3.4.6 Drier Summers

- A discussion with the mains water provider will be carried out regarding the supply of water and any likely drought restrictions;
- A contingency plan will be considered for the importation of water in periods of reduced water availability though this is unlikely to prove practicable given other simultaneous pressures on the utility providers;
- Site water use will be minimised by design using a closed loop cooling system and as efficient an electrolyser feed water treatment system as can be reasonably procured.

3.4.7 River Flow

Mitigation measures for flooding is summarised in **section 3.4.3** and are deemed suitable for the potential risk of flooding from increased river flow. Reduced river flows are not envisaged to affect the Installation and therefore, mitigation measures for this have not been considered.

3.4.8 Storms

- Mitigation for flooding is summarised in **section 3.4.3**, and is deemed applicable for the risk of flooding arising from stormy weather;
- HYRO will ensure suitable resilience to increased windshear by design;
- HYRO will consider lightning protection on roofs if necessary;
- HYRO will be prepared for process failures during stormy weather and potential need for unplanned shutdowns;
- HYRO will commit to keeping the site tidy and remove objects that could blow around;
- HYRO will ensure buildings are secured against driving winds by closing all doors and windows during a storm event; and
- HYRO will inspect the Installation infrastructure after a storm event.

3.5 Climate Change Adaptation Plan

A Climate Change Adaptation Plan (CCAP) has been compiled following EA guidance (Environment Agency, 2023) and provided below. The CCAP will be embedded into the EMS.

3.5.1 Objectives and Justification

The **objectives** of the CCAP for HYRO are to address, and periodically revisit, the impacts and risks associated with climate change to minimise negative effects, build resilience, and ensure sustainable operation of the Installation over its life cycle.

The **justification** of the CCAP for HYRO relate to the need to safeguard critical infrastructure and employees for their operations and improve overall resilience in the face of a changing climate.

3.5.2 Assumptions and Uncertainties

It is assumed that the Installation is not at serious risk from climate change, especially once the mitigation measures have been actioned. However, climate change models, while instrumental in predicting future climate patterns, are characterised by inherent uncertainties. In addition, short-term extremes can be unprecedented and largely unpredictable in terms of frequency and severity.

This further backs up the need for at least annual review of this document to ensure changing climate impacts are being considered throughout the life span of the Installation.

3.5.3 Decision-Making Approach

The Green Hydrogen 3 Limited decision-making approach is summarised in **Figure 3.3.** The process steps enable Green Hydrogen 3 Limited to make carefully considered decisions.

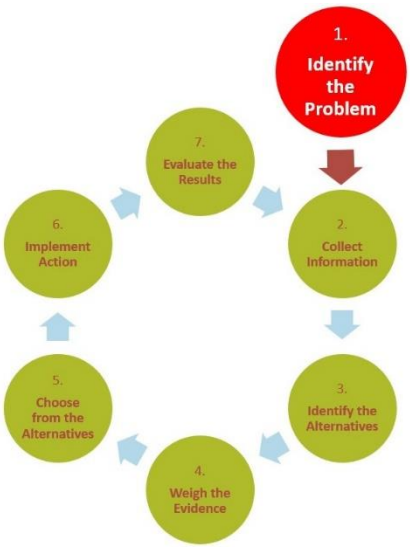

Figure 3-3 - Decision-Making Approach

3.5.4 Relationship with Existing Site Plans

The CCAP complements and integrates with existing site plans such as the Flood Risk Assessment and Drainage Strategy which establishes the risk associated with the proposed development and proposes suitable mitigation (if required).

This section will be updated with other site plans as required.

3.5.5 Prioritisation Process

The prioritisation process utilised at Green Hydrogen Three Limited will operate on an importance and urgency scale (**Figure 3-**). Climate change matters of the highest importance and urgency will be acted upon immediately. This is at the discretion of those responsible.

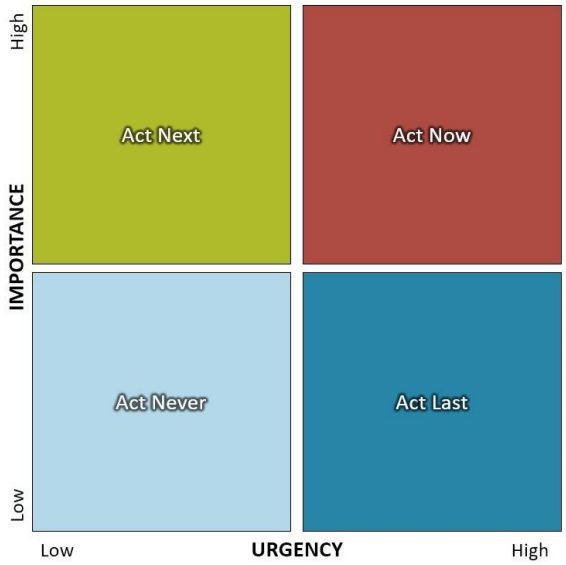

Figure 3-4 - Prioritisation Process

3.5.6 Documenting of CCAP Actions

HYRO will document actions in a suitable format (e.g., a Microsoft Excel Spreadsheet) that includes a prioritised list of adaptation actions, their associated risks, estimate costs, timelines, and responsible persons. The document serves as a tracker and roadmap for implementing the CCAP mitigations ensuring resources and efforts are focused on actions with the highest potential to reduce vulnerability and enhance resilience. In addition, HYRO will record details of any extreme weather events and if there were any impacts upon the Installation. Control of these documents will be described in the emerging EMS.

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