# Kintore Hydrogen Plant

## Environmental Impact Assessment Report
## Chapter 12: Climate Change

**Date:** July 2024

Kintore Hydrogen
A STATERA COMPANY

## Environmental Impact Assessment Report

**Volume 2**

**Chapter 12**

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# 1 Introduction

## 1.1 Purpose of this chapter

1.1.1 This chapter of the Environmental Impact Assessment Report (EIAR) presents the findings of Environmental Impact Assessment (EIA) work undertaken concerning potential impacts of Kintore Hydrogen Plant on climate change.

1.1.2 Climate change in the context of EIA can be considered broadly in two domains: the impact of greenhouse gas emissions (GHGs) caused or avoided directly or indirectly by the proposed development, which contribute to climate change; and the potential impact of changes in climate on the development, which could affect it directly or could modify its other environmental impacts.

1.1.3 This chapter focuses on the impact of the proposed development on climate change due to its direct and indirect GHG emissions. As agreed through EIA scoping (see Section 1.3), the main potential impact of climate change on the proposed development affects flood risk, which has been assessed in Chapter 13: Soils, Geology and Water Environment. In addition, the potential changes in the future baseline due to climate change are discussed, where relevant, in Section 3.2: Future Baseline of each EIAR topic chapter in Volume 2. Non-flooding climate risks to the proposed development have therefore been scoped out.

1.1.4 This EIAR chapter:

- presents the environmental baseline established from desk studies, surveys and consultation to date;
- presents the potential environmental effects on climate change arising from Kintore Hydrogen Plant, based on the information gathered and the analysis and assessments undertaken;
- identifies any assumptions and limitations encountered in compiling the environmental information; and
- highlights any necessary monitoring and/or mitigation measures that could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

## 1.2 Planning policy and legislative context

1.2.1 Under the guidance used in this assessment, climate change policy and legislation at a local and national level forms part of the context used to judge the significance of GHG emission effects, together with published advice of experts on the adequacy of that policy and on measures needed to successfully implement it.

1.2.2 There is much legislation and policy concerning climate change, energy supply and hydrogen or other low-carbon technologies in general, which is not exhaustively listed; this summary focuses on aspects of legislation or policy where these three matters intersect.

### Net Zero legislation and associated national policy

1.2.3 The Climate Change Act 2008[1] (as amended by the Climate Change Act 2008 (2050 Target Amendment) Order 2019[2]) commits the UK government, including devolved administrations, to reducing GHG emissions by at least 100% of 1990 levels by 1050: a net zero target.

1.2.4 The Scottish Government has set a further net zero target of 100% reduction from 1990 levels by 2045, detailed within the Climate Change (Scotland) Act 2009[3] (as amended by the Climate Change (Emissions Reduction Targets) (Scotland) Act 2019[4]). The Climate Change (Scotland) Act 2009 includes a framework for setting a series of interim national carbon budgets and plans for national adaptation to climate risks. The 2008 and 2009 Acts also established the Climate Change Committee with a statutory role to give advice to government (including the Scottish Government) on carbon budgets, to report on progress in reducing carbon, and to give advice on climate risks and adaptation. Advice from the Climate Change Committee, while not adopted policy, is strongly relevant to consider and discussed further below.

1.2.5 At present, the Fourth, Fifth and Sixth Carbon Budgets for the UK, set through The Carbon Budget Orders 2011, 2016 and 2021, are 1,950 $MtCO_2$ for 2023 to 2027, 1,725 $MtCO_2$ for 2028 to 2031 and 965 $MtCO_2$ for 2033 to 2037. The Sixth Carbon Budget is the first that is consistent with the UK's net zero target, requiring a 78% reducing in GHG emissions by 2035 from 1990 levels. The UK's updated Nationally Determined Contribution (NDC) under the Paris Agreement commits the UK to reducing economy-wide GHG emissions by at least 68% by 2030 compared to 1990 levels[5]. Scotland's indicative Nationally Determined Contribution (NDC) is to reduce emissions of all major greenhouse gases by at least 75% compared to a 1990/1995 baseline by 2030[6].

1.2.6 Under the 2009 Act, Scotland's interim targets to net zero by 2045 are a reduction of 75% on the base year by 2030 and 90% by 2040. Annual emission targets are then set, under the act, as a percentage change interpolating between these points.

However, in April 2024, announced a forthcoming change to this legislation to remove the interim targets, with a reduction of 75% by 2030 being considered unachievable. The Scottish Government has requested advice from the Climate Change Committee in instead setting five-yearly budgets, as used for the UK and Wales[7].

1.2.7 Under s.35 of the Climate Change (Scotland) Act 2009, the Scottish Ministers must lay a climate change plan before the Scottish Parliament that sets out the proposals and policies for meeting the emissions reduction targets during the plan period. 'Securing a green recovery on a path to net zero: climate change plan 2018-2032 – update' is the present such report[8]. The document sets out the iterative approach on how Scotland will transition over the plan period, with particular reference to developing the role of hydrogen in the energy system. Alongside the climate change plan, the Scottish Government has published a Hydrogen Policy Statement and, following that, a Hydrogen Action Plan.

1.2.8 The Hydrogen Policy Statement[9] outlines the vision for Scotland to "*become a leading Hydrogen Nation* [sic] *in the production of reliable, competitive, sustainable hydrogen*". Within the statement, the Scottish Government sets out an ambition of achieving 5 GW of hydrogen production from renewable and low-carbon sources by 2030 and 25 GW by 2045, and confirms that both renewable and low-carbon hydrogen will play an increasingly important role in the energy transition to net zero in 2045. The Hydrogen Action Plan[10] describes the actions needed and the progress to date for achieving these policies.

1.2.9 In terms of policy for the UK as a whole, the 'Ten Point Plan for a Green Industrial Revolution'[11], which was published in 2020, also aims for the UK to develop 5 GW of low carbon hydrogen capacity by 2030. The UK Hydrogen Strategy[12] identified a major role for hydrogen in meeting future energy demand and sets out the progress needed in the 2020s to deliver the 5 GW production ambition by 2030 and position hydrogen to help meet the Sixth Carbon Budget and net zero commitments the UK has.

1.2.10 The UK Net Zero Strategy (Build Back Greener)[13], as revised in 2022 after court challenge, set out the UK's plans to achieve net zero emissions by 2050. Alongside this target is the ambition to fully decarbonise the UK's power system by 2035, with hydrogen set to supplement electricity as a source of energy.

1.2.11 The British Energy Security Strategy[14], published in 2022, states that the government will "*double our UK ambition for hydrogen production to up to 10GW by 2030, with at least half of this from electrolytic hydrogen".* The Hydrogen Production Delivery Roadmap[15] sets out the vision for hydrogen production to 2035.

## Advice of the Climate Change Committee

1.2.12 The Climate Change Act 2008 and the Climate Change (Scotland) Act 2009 set out a statutory role for the Climate Change Committee, to provide regular advice on emissions reduction targets and regular independent assessments of the UK's Scotland's emission reduction progress and climate adaptation programmes.

1.2.13 In the latest review of Scotland's progress in reducing emissions[16], the Committee reports that the Scottish Government is failing to achieve Scotland's ambitious climate goals. The key messages are:

- *"Scotland's annual target was missed again;*
- *the acceleration required in emissions reduction to meet the 2030 target is now beyond what is credible;*
- *current overall policies and plans in Scotland fall far short of what is needed to achieve the legal targets under the Scottish Climate Change Act;*
- *the Scottish Government has delayed its draft Climate Change Plan; and*
- *most key indicators of delivery progress are off track, with tree planting and peatland restoration rates, heat pump installations, electric van sales and recycling rates significantly so."*

1.2.14 At the time the report was published, the Scottish Government was yet to release its draft climate change plan 2018-2032, but this has now been published (see reference above). There is now a path to Scotland's net zero target, but the Committee states that stronger action is needed to reduce emissions across the economy. The transport and buildings sectors will require a particularly rapid increase in the rate of emissions reduction to meet the targets set out in the climate change plan 2018-2032.

## National Planning Policy

1.2.15 The National Planning Framework 4 (NPF4)[17] sets out the national planning policies for Scotland. Policy 11 aims to encourage, promote and facilitate all forms of renewable energy development onshore and offshore, including emerging low-carbon and zero emissions technologies such as hydrogen.

1.2.16 Furthermore, Policy 1 states that when considering development proposals, significant weight will be given to the global climate crisis.

## Local planning and climate policy

1.2.17 Policy C2: Renewable Energy of the Aberdeenshire Local Development Plan[18] states that the Council will support renewable energy developments, including solar, wind, biomass and hydro-electricity projects, as well as energy storage projects, which are in appropriate sites and of the appropriate design. Assessment of the acceptability of such developments will take account of any effects on renewable energy targets and greenhouse gas emissions, amongst other aspects. Other renewable energy developments will be required to relate well to the source of the renewable energy required for operation. Although hydrogen is not explicitly mentioned by this policy, in line with the national Hydrogen Action Plan, 'green hydrogen' production from renewable energy sources is considered part of the renewable and low-carbon energy economy as referenced in Policy C2.

## 1.3 Consultation

1.3.1 No comments were made specific to the climate change assessment in the Scoping Opinion, and the proposed scope and assessment approach overall were agreed. The Scottish Environment Protection Agency (SEPA) confirmed that a flood risk assessment, with appropriate climate change allowances in line with SEPA guidance, is required.

1.3.2 Table 1.1 provides details of how this has been considered in the production of this EIAR and cross-references to where this information may be found.

**Table 1.1: Key points raised during scoping and consultation to date**

| Date | Consultee and type of response | Points raised | How and where addressed |
|---|---|---|---|
| November 2023 | Aberdeenshire Council – Scoping Opinion | Scope and approach of EIA agreed, including the scoping-out of a climate risk assessment, with the exception of flood risk. Flood risk with appropriate climate change allowance in line with SEPA guidance is required. | Assessment has been undertaken in accordance with approach agreed at scoping stage. EIAR Chapter 13: Soils, Geology and the Water Environment has addressed the flood risk with appropriate climate change allowance. |
| November 2023 | Scottish Environmental Protection Agency (SEPA) – Scoping Opinion | SEPA require that proposals on peatland or carbon rich soils should follow the requirements of NPF4 Policy 5. | Section 3.1 addresses the baseline land use and establishes that the proposals are not located on peatland or carbon rich soils. |

# 2 Assessment Approach

## 2.1 Guidance

2.1.1 The main guidance used for the assessment of GHG emissions has been the Institute of Environmental Management and Assessment (IEMA) guide 'Assessing Greenhouse Gas Emissions and Evaluating their Significance'[19]. Additional guidance used for the quantification of GHG emissions includes:

- The Greenhouse Gas Protocol suite of documents[20];
- Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book[21]; and
- UK Government GHG Conversion Factors for Company Reporting[22].

## 2.2 Assessment methodology

2.2.1 In overview, GHG emissions have been estimated by applying published emissions factors to activities in the baseline and to those required for the proposed development. The emissions factors relate a given level of activity, a physical or chemical process, or amount of fuel, energy or materials used to the mass of GHGs released as a consequence.

2.2.2 The assessment has considered (a) the direct and indirect GHG emissions arising from the proposed development, (b) any GHG emissions that it displaces or avoids, compared to the current or future baseline, and hence (c) the net impact on climate change due to these changes in GHG emissions overall.

2.2.3 The GHG emissions considered in this assessment are those in the 'Kyoto basket'[1] of global warming gases expressed as their $CO_2$-equivalent global warming potential (GWP). This is denoted by $CO_2e$ units in emissions factors and calculation results. GWPs used are typically the 100-year factors in the Intergovernmental Panel on Climate Change Sixth Assessment Report or as otherwise defined for national reporting under the United Nations Framework Convention on Climate Change (UNFCCC).

## 2.3 Study area

2.3.1 GHG emissions have a global effect rather than directly affecting any specific local receptor. The impact of GHG emissions occurring due to the proposed development on the global atmospheric concentration of the relevant GHGs, expressed in $CO_2e$, is therefore considered within this assessment. As GHG impacts are global and cumulative with all other sources, no specific geographical study area is defined for the identification of receptors or assessment of effects.

2.3.2 However, GHG emissions caused by an activity are often categorised into 'scope 1', 'scope 2' or 'scope 3' emissions, following the guidance of the WRI and the WBCSD Greenhouse Gas Protocol suite of guidance documents.

- Scope 1 emissions: released directly by the entity being assessed, e.g. from combustion of fuel at an installation;
- Scope 2 emissions: caused indirectly by consumption of imported energy, e.g. from generating electricity supplied through the national grid to an installation; and
- Scope 3 emissions: caused indirectly in the wider supply chain, e.g. in the upstream extraction, processing and transport of materials consumed or the downstream use of products from an installation.

2.3.3 This assessment has sought to include emissions from all three scopes, where this is material and reasonably possible from the information and emissions factors available. This is in line with the 2024 Supreme Court judgement in the 'Finch' case[23] on the requirement to assess direct and indirect effects caused by a development where this causality is established and the assessment can be made without "speculation and conjecture".

2.3.4 The majority of GHG emissions are likely to occur within the territorial boundary of the UK and hence within the scope of the UK's national carbon budgets. However, in recognition of the climate change effect of GHG emissions (wherever occurring) and the need, as identified in national policy, to avoid carbon leakage overseas when

[1] The Kyoto basket encompasses the following greenhouse gases: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride ($SF_6$).

reducing UK emissions, potential scope 3 GHG emissions that may physically occur outside the UK have been considered where relevant.

## 2.4 Baseline study

### Desktop study

2.4.1 Information on current and future GHG emissions was collected through a desktop review of existing studies and datasets. These are summarised at Table 2.1 below.

**Table 2.1: Summary of desktop study sources**

| Title | Source | Year | Ref. |
|---|---|---|---|
| UK Government GHG Conversion Factors for Company Reporting | DESNEZ and BEIS | 2024 | [22] |
| Valuation of Energy Use and Greenhouse Gas: Supplementary guidance to the HM Treasury Green Book, and supporting data tables | BEIS and DESNEZ | 2023 | [21] |
| Life Cycle Assessment of Four Floating Wind Farms around Scotland Using a Site-Specific Operation and Maintenance Model with SOVs | Struthers *et al.* | 2023 | [24] |

## 2.5 Uncertainties and/or data limitations

2.5.1 There is uncertainty about future climate and energy policy and market responses, which affect the likely future carbon intensity of energy supplies. Government projections consistent with national carbon budget commitments have been used in the assessment.

2.5.2 The proposed development is a hydrogen production plant and its operating times may vary, depending on the needs of National Gas and the energy market. This affects both the gross GHG emissions and the net effect of other energy supply sources displaced. The assessment has considered the expected annual operating hours (defined in Table 2.2) for gross emissions and a range of scenarios, described in Section 4.2.

2.5.3 Due to the early stage of development design and the flexibility sought by the applicant within the design envelope, limited information is available about proposed construction materials and activities. The assessment of construction impacts has therefore used a screening approach and published information to consider whether these impacts are likely to be material and significant to the total effects of the proposed development.

## 2.6 Impact assessment criteria

2.6.1 The significance of an effect is determined based on the magnitude of an impact and the sensitivity of the receptor. This section describes the criteria applied in this chapter to characterise the magnitude of potential impacts and sensitivity of receptors.

### Magnitude of impact

2.6.2 As GHG emissions can be quantified directly and expressed based on their GWP as tonnes of $CO_2$-equivalent ($tCO_2e$) emitted, the magnitude of impact is reported numerically rather than requiring a descriptive scale.

### Sensitivity of receptor

2.6.3 GHG emissions have a global effect rather than directly affecting any specific local receptor to which a level of sensitivity can be assigned. The global atmospheric mass of the relevant GHGs and consequent warming potential, expressed in $tCO_2e$, has therefore been treated as a single receptor of high sensitivity. It is considered to be of high sensitivity given the importance of the global climate as a receptor, the limited and decreasing capacity to absorb further GHG emissions without severe climate change resulting, and the cumulative contribution of GHG emission sources.

### Significance of effect

2.6.4 The IEMA assessment guidance for GHG emissions describes five levels of significance for emissions resulting from a development, each based on whether the GHG emission impact of the development will support or undermine a science-based 1.5°C-compatible trajectory towards net zero.

2.6.5 To aid in considering whether effects are significant, the guidance recommends that GHG emissions should be contextualised against pre-determined carbon budgets, or applicable existing and emerging policy and performance standards where a budget is not available or not meaningfully applicable at the scale of development assessed. It is a matter of professional judgement to integrate these sources of evidence and evaluate them to determine significance.

2.6.6 Taking the guidance into account, the proposed development's GHG emissions have been contextualised:

- with reference to the magnitude of gross and net GHG emissions as a percentage of the UK's national carbon budgets (as no five-yearly budgets are set yet for Scotland);

- through comparing the GHG emissions intensity of the proposed development with current baseline emissions intensity for energy use and projections or policy goals for future changes in that baseline; and,
- with reference to whether the proposed development contributes to, and is in line with, the applicable Scottish and UK policy for GHG emissions reductions, where this policy is consistent with science-based commitments to limit global climate change to an internationally agreed level.

2.6.7 Effects from GHG emissions are described in this chapter as adverse, negligible or beneficial based on the following definitions, which closely follow the examples in Box 3 of the IEMA guidance.

- **Major Adverse:** the proposed development's GHG impacts would not be compatible with the UK's or Scotland's net zero trajectory. Its GHG impacts would not be mitigated, or would be compliant only with do-minimum standards set through regulation. The proposed development would not provide further emissions reductions required by existing local and national policy for projects of this type. A project with major adverse effects is locking in emissions and does not make a meaningful contribution to the UK's and Scotland's trajectory towards net zero
- **Minor Adverse:** the proposed development's GHG impacts would not be fully compatible with the UK's and Scotland's net zero trajectory. Its GHG impacts would be partially mitigated and may partially meet the applicable existing and emerging policy requirements, but it would not fully contribute to decarbonisation in line with local and national policy goals for projects of this type. A project with moderate adverse effects falls short of fully contributing to the UK's and Scotland's trajectory towards net zero.
- **Minor Adverse:** the proposed development's GHG impacts would be compatible with the UK's and Scotland's 1.5°C trajectory and would be fully consistent with up-to-date or emerging policy and good practice emissions reduction measures. A project with minor adverse effects is fully in line with measures necessary to achieve the UK's and Scotland's trajectory towards net zero.
- **Negligible:** the proposed development would achieve emissions mitigation that goes well beyond existing and emerging policy compatible with the 1.5°C trajectory, such that radical decarbonisation or net zero is achieved well before 2050. A project with negligible effects provides GHG performance that is well 'ahead of the curve' for the trajectory towards net zero and has minimal residual emissions.
- **Beneficial:** the proposed development would result in emissions reductions from the atmosphere, whether directly or indirectly, compared to the without-project baseline. As such, the net GHG emissions would be below zero. A project with beneficial effects substantially exceeds net zero requirements with a positive climate impact.

2.6.8 **Major** and **moderate adverse** and **beneficial** effects are considered to be **significant.**

2.6.9 **Minor adverse** and **negligible** effects are considered to be **not significant.**

## 2.7 Maximum design envelope parameters for assessment

2.7.1 The maximum design envelope parameters identified in Table 2.2 have been selected as those having the potential to result in the greatest effect on an identified receptors or receptor groups. These parameters have been identified based on the overview description of the development provided in Chapter 2: Project Description and Site Setting

2.7.2 Effects of greater adverse significance are not predicted to arise should other development designs, within the project design envelope parameters, be taken forward.

**Table 2.2: Maximum design envelope parameters assessed**

| Potential impact | Maximum design parameter | Justification |
|---|---|---|
| **Construction phase** | | |
| Embodied carbon in construction materials and equipment of hydrogen plant | These are a *de minimis* element of total lifecycle emissions including operational use. | A reasonable assumption where specific embodied carbon information about manufactured components or estimates of construction material volumes are not available. |
| **Operation phase** | | |
| GHG emissions from operation of hydrogen plant | The hydrogen plant will use 3 GWh of electricity to produce 54,408 kg/hour of hydrogen at full capacity. It will have a typical annual capacity factor of up to 40%. | Reasonable maximum assumption for full operational capacity of the hydrogen plant. |

| Potential impact | Maximum design parameter | Justification |
|---|---|---|
| Fugitive GHG emissions | Hydrogen release during start-up, shut-down and any abnormal events will be managed by flaring. No fugitive emissions of hydrogen are likely.<br>No fugitive emissions of sulphur hexafluoride are likely should a gas-insulated substation be taken forward in the design. | Reasonable expectation for the safe operation of the hydrogen plant. |

## 2.8 Impacts scoped out of the assessment

2.8.1 The impacts listed in Table 2.3 have been scoped out of the assessment for climate change as agreed through the EIA scoping process detailed in Chapter 5: Scoping and Consultation.

**Table 2.3: Impacts scoped out of the assessment**

| Potential impact | Justification |
|---|---|
| **Construction phase** | |
| GHG emissions from construction activities | These are considered to be minimal and not significant relative to the operational phase impacts. A screening calculation has been made to confirm this, reported below, and mitigation has also been recommended as a matter of good practice. |
| **Operation phase** | |
| Impacts or risks of climatic changes on operation of the development other than flood risk | Probabilistic projections of change in climatic variables under a high emissions scenario were reviewed at scoping stage and not considered to be of sufficient magnitude to require any specific design response for resilience or to impact on the proposed development's operation. The influence of climate change on flood risk has been assessed in Chapter 13: Soils, Geology and the Water Environment. |

## 2.9 Mitigation measures adopted as part of Kintore Hydrogen Plant

2.9.1 A number of measures have been designed in to Kintore Hydrogen Plant to reduce the potential for impacts on climate change. These are listed in Table 2.4.

**Table 2.4: Designed-in mitigation measures**

| Measures adopted as part of Kintore Hydrogen Plant | Justification |
|---|---|
| The concept and purpose of the development is to use low-carbon electricity (primarily expected to be Scottish wind power) to produce hydrogen and displace natural gas use. Operating model assumes up to ~40% annual operation based on expected availability and cost of low-carbon, primarily renewable electricity. | This would reduce GHG emissions from natural gas use and help to fulfil national net zero energy policy for hydrogen production. |
| Construction Environment Management Plan (CEMP) | A CEMP would be followed during construction that would include requirements to use well-maintained construction plant compliant with current emission standards, to minimise plant idling and to minimise materials wastage. An Outline CEMP accompanies the planning application in principle. |
| Sustainable travel plan incorporating a coach shuttle service for construction and workforce access, with limited on-site car parking; and provision of electric vehicle charging for on-site parking. Details are provided in Chapter 9: Transport and Access and Appendix 9.1: Transport Assessment (incorporating proposed Travel Plan information). | Minimises private car and single occupancy vehicle access during construction and operation in favour of more sustainable coach transport from Aberdeen including park & ride and rail station. |
| Flare used to manage any hydrogen releases by oxidising it to water vapour | Use of the flare system rather than cold venting of any hydrogen release required during start-up, shut-down and abnormal events avoids the secondary GWP effect of hydrogen releases. |

# 3 Baseline environment

## 3.1 Current baseline

3.1.1 The current physical baseline condition of the electrolysis plant site, above-ground installation for hydrogen export, pipeline routes and water intake/discharge point with regard to GHG emissions is their use as agricultural land. Although Kintore Substation is currently being expanded westwards to the edge of the site, there is no existing built development with GHG emissions on the electrolysis plant site. There is a fringe of bog woodland and gorse scrub at the northern edge of the site, with smaller stands of coniferous trees in the central part of the site.

3.1.2 Depending on the composition, woodland, other vegetation and soil carbon can be important stocks that may be lost through disturbance due to proposed built development. However, the existing land use is not a significant carbon store as the land does not include peat deposits, carbon-rich soils or extensive woodland, but rather has sparse vegetation in the areas to be developed. Therefore, existing carbon stocks and fluxes are considered to be a *de minimis* part of the baseline and not significant to the assessment.

3.1.3 The baseline carbon intensity of generating electricity supplied from the national grid which would be used by the proposed development to produce hydrogen has been established based on the present-day life cycle carbon impacts of generating this electricity, from published national emission factor and lifecycle assessment (LCA) sources. Similarly, the baseline carbon intensity of natural gas use in the UK (mainly for heating and industry) has been established from published national emission factor sources.

## 3.2 Future baseline

3.2.1 The future baseline GHG emissions for existing land-use without the proposed development are expected to remain similar, with a decrease in agriculture-related emissions over time in line with Scotland's and the UK's national climate change policies.

3.2.2 The future baseline for electricity generation and natural gas use depends broadly on future energy and climate policy in Scotland and the UK, and more specifically (with regard to day-to-day emissions) on the demand for operation of the proposed development compared to other generation sources available, influenced by commercial factors and National Grid's needs. The carbon intensity of electricity generation is likely to be reduced over time in the future baseline to meet the Scottish and UK carbon reduction targets. Without blending or replacement by hydrogen, it is unlikely that the carbon intensity of natural gas supply and use will reduce appreciably.

### Climate change

3.2.3 The Met Office Hadley Centre (MOHC) UK Carbon Projections ('UKCP18') dataset provides probabilistic projections of change in climatic parameters over time for 25 km grid squares across the UK. Projected changes for a RCP8.5 future global greenhouse gas emissions scenario have been reviewed for the 2030-2059 and 2070-2099 periods. The influence of these potential changes on future baseline for the EIAR has been discussed, where relevant, within this 'Future Baseline' chapter section for each of the other topic chapters in Volume 2.

# 4 Assessment of Effects

## 4.1 Construction phase

4.1.1 Indirect GHG emissions would be caused in the supply chain for materials (such as concrete and steel) and engineered products (such as the electrolyser modules) to construct the proposed development. Construction plant on site will also cause direct GHG emissions from fuel combustion and there would be small indirect emissions from electricity and water use.

4.1.2 As set out in EIA scoping, the construction stage impacts are likely to be only a small component of the proposed development's long-term effect on climate change and are unlikely to affect the judgement of significance of the full life-cycle effects. On that basis, detailed assessment was proposed to be scoped out of the EIA and this was accepted in the Scoping Opinion. However, a screening calculation is provided here to confirm that the position anticipated at the EIA scoping stage was correct.

4.1.3 The proposed development's gross GHG emissions would be dominated by its operational phase, and the ongoing emissions of such a facility year on year will typically outweigh the one-off 'embodied carbon'[2] cost of producing building materials and constructing the proposed development. However, this is difficult to quantify in detail at an early stage of design where full bills of quantities and materials specifications for construction are not yet available.

4.1.4 The IEMA guidance indicates that emissions sources individually comprising less than 1% of total emissions, and collectively up to 5%, can be excluded from an assessment. This can be necessary in order to provide a proportionately-scoped assessment and where some details are not available, for example at an early stage of design.

4.1.5 A screening approach has therefore been taken to consider whether construction-stage GHG emissions could be material to the total impact of the project and the significance of effects. Materiality is a term used in greenhouse gas accounting to distinguish minor and major emission sources for a proportionate assessment, with non-material or *de minimis* sources being those that are unlikely to appreciably affect the total or are likely to be within its uncertainty range.

**Magnitude of impact**

4.1.6 The net operational stage cumulative GHG emissions impact up to the year 2050, discussed in the following section, would be -28 $GtCO_2e$. One percent of this, around 281,641 $tCO_2e$, would be equivalent to the embodied carbon of around 1.9 million tonnes of concrete or 92 thousand tonnes of steel: far greater amounts than are realistic for construction of the proposed development.

4.1.7 The HyNet North West Hydrogen Production Plant[25] provides an example of a large scale proposed hydrogen production facility to cross-check this, albeit there is some dissimilarity in equipment as the HyNet project is for steam reformation of methane to produce hydrogen rather than electrolysis, so embodied carbon may differ. Based on the embodied carbon of construction materials estimated by that project and scaled to the hydrogen production capacity of the proposed development, construction-stage embodied carbon would be around 42,600 $tCO_2e$. This is again far less than 1% of the predicted operational emission impact of the proposed development up to the year 2050.

4.1.8 The construction of the proposed development would therefore not constitute a quantity of materials with embodied carbon surpassing the 1% *de minimis* threshold and as such, the magnitude of impact from construction is considered to be a **negligible** contributor to the overall lifecycle impact of the development.

**Sensitivity of the receptor**

4.1.9 The atmospheric mass of the relevant GHGs and consequent warming potential is considered to be of high vulnerability and limited recovery. The sensitivity of the receptor is therefore considered to be **high**.

**Significance of effect**

4.1.10 Overall, it is predicted that the **negligible** impact on the **high** sensitivity receptor would result in a **negligible** effect, which is not significant.

**Further mitigation or enhancement**

4.1.11 Although no significant adverse effects have been predicted, in consideration of IEMA guidance that all GHG emissions are potentially significant due to the cumulative global effect, and government policy seeking GHG emissions reductions across all economic

[2] The GHG emissions associated with extracting raw materials, manufacturing into products and transportation that are 'embodied' in construction materials used.

sectors including construction, the further good-practice mitigation is recommended for the detailed design and construction phase:

- undertake a detailed life-cycle assessment (LCA) during engineering/architectural design of the development to identify construction carbon hotspots and guide optioneering to achieve reductions;
- use recognised frameworks such as PAS2080: Carbon Management in Infrastructure and Built Environment[26] and the UKGBC's forthcoming Net Zero Carbon Building Standard[27] (building on the existing UKGBC framework definition for net zero buildings, and expected to be published later in 2024) to define a target for substantially reduced or net zero emissions from construction and manage this through the EPC/Principal Contractor interface;
- use verified Environmental Product Declarations and engage with or require the EPC contractor to engage with the key technology providers and tier one suppliers for the main materials and major engineered components to procure lower-carbon products. For bulk materials, source these locally where possible to reduce transport GHG emissions; and
- give consideration in the detailed design LCA to future decommissioning, incorporating materials and fixings capable of eventual dismantling and re-use where feasible.

**Residual effect**

4.1.12 The residual effect following further mitigation is predicted to be **negligible**, which is not significant.

### Future monitoring

4.1.13 Monitoring and management of GHG emissions should be undertaken through a design-stage and as-built stage LCA, in line with the construction carbon management and reduction standards referenced above.

## 4.2 Operational phase

### Operational GHG emissions

**Magnitude of impact**

4.2.1 The electrolysis process at full capacity will consume up to 3 gigawatt-hours (GWh) of electricity to produce up to 54 tonnes per hour of hydrogen for export, which is equivalent to 1.8 GWh of energy content (net calorific value basis). It is expected that Kintore Hydrogen Plant will have an annual capacity factor of up to around 40%, accounting for variability in the renewable electricity supply market and hydrogen demand.

4.2.2 Wind energy generation accounted for 29.4% of UK total electricity generation (including both renewables and non-renewables) in 2023[28]. In Scotland, in 2022, wind energy generation accounted for 78% of renewable electricity generation[29]. Together, off-shore and on-shore wind energy sources contributed the greatest proportion of non-dispatchable[3] renewable energy generation in 2023[30]. Its dominance within the non-dispatchable renewable energy sector is likely to continue, with an additional 30 GW of offshore wind planned in the next 10 years as part of the ScotWind leasing round[31] and 140 GW offshore wind recommended to be deployed by 2050[32]. As such, it is expected that this is the source of renewable energy that is most likely to be curtailed[4] during periods of surplus demand.

4.2.3 Therefore, for the purpose of this assessment, the indirect GHG emissions associated with offshore wind farms for has been used to represent the carbon intensity of generating electricity that is consumed by the proposed development to produce hydrogen.

4.2.4 The lifecycle carbon intensity of offshore wind has been informed by Struthers *et al* (2023)[33], who undertook a life cycle assessment (LCA) of the International Energy Agency (IEA) 15 MW Reference Wind Turbine (RWT), which is representative of designs that will be deployed in commercial-scale arrays at multiple locations around Scotland in the ScotWind leasing round. The LCA compiled data from four wind farm sites, totalling 668 wind turbines, regarding the GHG impacts of offshore wind generation across the materials and manufacturing, installation, transportation, operation, maintenance, dismantling, removing and landfill and recycling lifecycle

[3] generating capacity that cannot be employed 'on demand', in this case because of the natural variability in wind

[4] a temporary deliberate reduction in generation below the available capacity, due to factors such as low power demand or insufficient transmission capacity.

stages. The median global warming impact varied from 17.4 to 26.3 $gCO_2e/kWh$. A lifecycle GHG intensity of 21.05 $gCO_2e/kWh$ was established, being the mean of the median values from each wind farm site.

4.2.5 Assuming that electricity used by the proposed development is generated from wind power (here taken as a proxy for the renewables mix in Scotland), the gross total GHG emissions from operation of the proposed development would be up to 221,278 $tCO_2e$/annum.

4.2.6 At full capacity, the proposed development will produce 190,646 tonnes of hydrogen every year with energy content of 6,354 GWh on a net calorific value basis. This will be exported from the site by pipeline and blended into the National Gas high-pressure gas network for onward transmission and use in Scotland and the wider UK. It will therefore displace use of an equivalent quantity (by energy content) of natural gas in the future baseline.

4.2.7 The carbon intensity of natural gas combustion, including upstream supply chain, is 236 $gCO_2e/kWh$[22]. Displacing this with hydrogen use (which has zero GHG emissions from combustion) will therefore avoid a total of 1,500,664 $tCO_2e$/annum from natural gas combustion in the future baseline.

4.2.8 The net GHG impact of the proposed development (being the balance of emissions from electricity use and gas displacement) is therefore estimated to be **-1,279,367 $tCO_2e$/annum**, i.e. a net beneficial impact**.**

4.2.9 As a further sensitivity test, the projected future baseline carbon intensity of electricity generation from marginal and grid-average sources, as published by BEIS[21], has also been used to calculate the proposed development's net GHG emissions. This is a check of whether the predicted net GHG emission benefit would still be expected if wind power generation (as used in the main scenario) were not representative of the carbon intensity of electricity supply during the proposed development's operating lifetime. The BEIS projections run to 2050 (after which little or no further change is projected), declining over time in line with the expected change in carbon intensity of electricity production to meet the UK's net zero target.

4.2.10 In 2029, the earliest expected year of proposed development commissioning and initial operation, the proposed development is estimated to cause net GHG emissions of -283,416 to -958,024 $tCO_2e$/annum depending on whether marginal or grid-average generation is assumed. In future years this is then projected to increase much further as the carbon intensity of electricity generation decreases. This confirms that a net beneficial impact is predicted under a range of future scenarios.

4.2.11 The full 3 GW of operational capacity has been assessed. Phased development would reduce the cumulative summed benefit by a given year but not alter the position overall.

4.2.12 Table 4.1 shows the net GHG emissions impact under each scenario up to the year 2050 and the cumulative total net impact by that point.

**Table 4.1: Net GHG emissions results**

| Year | Net GHG emissions ($tCO_2e$/annum) | | |
|---|---|---|---|
| | Offshore wind | Projected marginal generator | Projected grid-average generator |
| 2029 | -1,279,367 | -283,416 | -506,269 |
| 2030 | -1,279,367 | -557,792 | -759,603 |
| 2031 | -1,279,367 | -777,048 | -858,362 |
| 2032 | -1,279,367 | -945,317 | -958,024 |
| 2033 | -1,279,367 | -1,074,456 | -1,000,031 |
| 2034 | -1,279,367 | -1,173,564 | -1,080,041 |
| 2035 | -1,279,367 | -1,249,625 | -1,169,390 |
| 2036 | -1,279,367 | -1,307,998 | -1,237,732 |
| 2037 | -1,279,367 | -1,352,797 | -1,289,170 |
| 2038 | -1,279,367 | -1,387,179 | -1,296,651 |
| 2039 | -1,279,367 | -1,413,564 | -1,301,832 |
| 2040 | -1,279,367 | -1,433,815 | -1,314,930 |
| 2041 | -1,279,367 | -1,437,595 | -1,319,371 |
| 2042 | -1,279,367 | -1,460,536 | -1,330,227 |
| 2043 | -1,279,367 | -1,469,819 | -1,338,272 |
| 2044 | -1,279,367 | -1,478,884 | -1,345,857 |
| 2045 | -1,279,367 | -1,486,711 | -1,353,692 |
| 2046 | -1,279,367 | -1,486,257 | -1,408,167 |
| 2047 | -1,279,367 | -1,486,208 | -1,414,692 |
| 2048 | -1,279,367 | -1,485,404 | -1,420,742 |
| 2049 | -1,279,367 | -1,485,031 | -1,422,508 |
| 2050 | -1,279,367 | -1,486,363 | -1,446,649 |
| **Cumulative total** | **-28,146,068** | **-27,719,377** | **-28,838,825** |

**Sensitivity of the receptor**

4.2.13 The atmospheric mass of the relevant GHGs and consequent warming potential is considered to be of high vulnerability and limited recovery. The sensitivity of the receptor is therefore considered to be **high.**

**Significance of effect**

4.2.14 In order to evaluate the significance of effect resulting from the impact magnitude, the proposed development's GHG emissions have been contextualised in the three ways discussed in paragraph 2.6.6: as a percentage of the national carbon budgets; compared to emissions intensity for baseline energy generation; and with reference to the relevant national policies for carbon reduction in the energy sector. These are discussed in turn.

National carbon budgets

4.2.15 The net GHG emissions from the proposed development would be a reduction equivalent to 0.37% of the 2028-2032 UK national carbon budget and 0.66% of the 2033-2037 budget. No national carbon budgets have yet been set for the remaining intervening periods to 2050, and no five-year carbon budgets have yet been set for Scotland at the time of writing.

4.2.16 The Tyndall Centre for Climate Change Research has recommended national and local authority-specific carbon budgets up to 2100 that, in its research, are considered to be an equitable distribution and compatible with a 1.5°C-aligned trajectory for the UK. The Tyndall Centre carbon budgets are more stringent than the UK national budgets (as advised by the Climate Change Committee): the budget for Scotland and Aberdeenshire would result in achieving zero or near zero carbon by 2041 rather than 2045.

4.2.17 The budget suggested by the Tyndall Centre in 2028-2032 for Scotland is 6,600,000 $tCO_2$/annum[34] and for Aberdeenshire is 320,000 $tCO_2$/annum[35]. The net GHG emissions from the proposed development would be a reduction equivalent to 19% of the suggested Scottish budget. It would be equivalent to 400% of the total suggested Aberdeenshire budget, i.e. the GHG emissions avoided would be four times greater than the total suggested budget for Aberdeenshire in that time period.

Baseline energy generation carbon intensity

4.2.18 The current and future baseline energy use has been considered, using current lifecycle GHG emissions for offshore wind and projected marginal sources in the future under a national scenario of decarbonisation. As demonstrated, the hydrogen fuel produced by the proposed development would have a lower lifecycle carbon intensity than the natural gas it would be displacing: 0.0348 $tCO_2e$/MWh for hydrogen compared to 0.2361 $tCO_2e$/MWh for gas.

National policy

4.2.19 National energy and climate policy strongly supports decarbonisation of energy supply through greater deployment of renewable and other low/zero carbon technologies, and recognises that this creates a greater need for alternative technologies including hydrogen. Scotland has substantial renewable energy resources, in particular offshore wind, but limited transmission capacity to the wider UK market; and the UK's national decarbonisation strategy recognises the challenges of replacing natural gas use in heating and industry with electricity. Blending of hydrogen into the gas grid and potentially pure hydrogen supply in future is therefore proposed as part of the solution, with national hydrogen strategies developed for the UK and for Scotland.

4.2.20 At 3 GW capacity, the proposed development would make a very substantial contribution to the Scottish Government's target of 5 GW hydrogen production by 2030 and 25 GW by 2045. The proposed development would therefore be an asset to the Scottish and UK governments in helping them meet their net zero targets by 2045 and 2050 respectively.

Conclusion

4.2.21 Overall, evaluating the magnitude of net GHG emissions impact due to the proposed development in the context of carbon budgets, the carbon intensity of its energy supply and its role in supporting energy and climate policy goals, the net impact is considered to be a net reduction in GHG emissions (considering the direct and indirect effects), which is a **beneficial** effect on the **high** sensitivity receptor that is **significant**.

**Further mitigation or enhancement**

4.2.22 No significant adverse effects have been predicted and no further mitigation is considered to be required.

**Residual effect**

4.2.23 No further mitigation or enhancement is required and so the residual effect remains **beneficial**, which is **significant**.

## Fugitive gases

**Magnitude of impact**

4.2.24 Hydrogen in its pure form does not have a direct GWP as it is not itself a greenhouse gas, but secondary chemical reactions with hydrogen in the atmosphere change the abundances of methane, ozone, stratospheric water vapor and aerosols. Using global atmospheric chemistry models, these reactions can be used to calculate a 100-year time-horizon GWP of hydrogen[36]: estimated to be 11.6±2.8. By comparison, natural gas (methane) has[37] a 100-year GWP of 27.9.

4.2.25 During start-up, shut-down and any abnormal events with the electrolysis modules, hydrogen will be flared to safely manage it. Fugitive releases of hydrogen during these processes are therefore not anticipated, and so GHG impacts from fugitive releases would be avoided.

4.2.26 When considering onward transmission of the exported hydrogen, blending hydrogen into the existing gas grid would not be expected to cause any materially greater fugitive emissions than existing use of the grid, and, as hydrogen has a lower GWP than methane, any fugitive emissions may actually result in a lesser impact compared to the baseline.

4.2.27 Within the design envelope assessed, the proposed development could use either an air-insulated substation (AIS) or a gas-insulated substation (GIS) design, the latter of which typically requires the use of sulphur hexafluoride ($SF_6$) as an insulating gas. $SF_6$ has a very high GWP of 24,300 and so its use is tightly regulated. To ensure fugitive emissions of $SF_6$ does not occur during operation of the GIS, the developer would comply with the F-gas Regulations (Regulation EU 517/2014, as retained in UK law post-Brexit by the European Union (Withdrawal) Act 2018) and good practice for installation, operation and end of life disposal of any components containing these gases, which would be undertaken by licensed specialist contractors. The proposed development would also be operated in accordance with requirements for gas safety.

4.2.28 These possible sources of fugitive emissions are considered to be *de minimis* and therefore the magnitude of impact is **negligible.**

**Sensitivity of the receptor**

4.2.29 The atmospheric mass of the relevant GHGs and consequent warming potential is considered to be of high vulnerability and limited recovery. The sensitivity of the receptor is therefore considered to be **high.**

**Significance of effect**

4.2.30 Overall, it is predicted that the **negligible** impact on the **high** sensitivity receptor would result in a **negligible** effect, which is **not significant**.

**Further mitigation or enhancement**

4.2.31 No significant adverse effects have been predicted and no further mitigation is considered to be required.

**Residual effect**

4.2.32 No further mitigation or enhancement is required and so the residual effect remains **negligible**, which is **not significant**.

### Future monitoring

4.2.33 The energy efficiency of the proposed development's operation would typically be monitored by audit under the PPC Permit regulated by SEPA. No additional future monitoring is required.

## 4.3 Inter-related effects

4.3.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the construction or operation of Kintore Hydrogen Plant on the same receptor.

**Project lifetime effects**

4.3.2 This section provides the assessment of the potential for effects that occur during more than one stage of the development's lifetime (such as phases of construction, operation or decommissioning) to interact such that they may create a more significant effect on a receptor than when assessed in isolation for each stage.

4.3.3 Direct and indirect emissions of GHGs would be released during the construction and operation and maintenance phases. However the combined effect of the emissions would not lead to project lifetime effects of greater significance compared to those assessed above.

**Receptor-led effects**

4.3.4 This section provides the assessment of the potential for effects via multiple environmental or social pathways to interact, spatially and temporally, to create a greater inter-related effect on a receptor than is predicted for each pathway (in its respective topic chapter) individually.

4.3.5 The effect of climate change on flood risk has been assessed in Chapter 13: Soils, Geology and Water Environment. The effects of a changing climate on the future baseline have been considered, where relevant, in that section of each respective topic chapter. It is not likely that the effects of other environmental topics considered in the EIAR would contribute to climate change and the release of GHG emissions or climate risks. Therefore, no additional receptor-led effects are predicted.

# 5 Cumulative Effects Assessment

5.1.1 All developments that emit GHGs have the potential to impact the atmospheric mass of GHGs as a receptor, and so may have a cumulative impact on climate change. Consequently, cumulative effects due to other specific local development projects are not predicted but are taken into account when considering the impact of the proposed development by defining the atmospheric mass of GHGs as a 'high' sensitivity receptor.

# 6 Conclusion and Summary

6.1.1 The likely significant effects of greenhouse gas (GHG) emissions from the proposed development on climate change have been assessed in this EIAR chapter. The global atmospheric mass of relevant GHGs and consequent warming potential, expressed in $CO_2$-equivalents, has been considered as a high sensitivity receptor affected by the proposed development.

6.1.2 Key uncertainties in the assessment concern future climate and energy policy and market responses, which affect the likely future baseline carbon intensity of energy supplies. A range of scenarios have therefore been considered.

6.1.3 Construction stage impacts have been evaluated and are considered not to be a material contributor to the total lifetime GHG emission changes caused by the proposed development. Nevertheless, as a matter of good practice, further mitigation at the detailed design stage to measure and reduce construction-stage GHG emissions has been recommended.

6.1.4 Net total GHG emissions caused directly and indirectly by operation of the proposed development have been calculated based on its expected electricity consumption, hydrogen production and the baseline use of natural gas that would be displaced by the hydrogen exported. The net impact of the proposed development would be a net reduction of -1,279,367 $tCO_2e$/annum in the main scenario assessed, where the lifecycle carbon intensity of electricity used is represented by offshore wind. In other scenarios tested based on the projected future carbon intensity of a range of generation sources, the net impact of the proposed development would remain a reduction in GHG emissions.

6.1.5 The predicted GHG emission reductions would be a beneficial effect of the proposed development that is considered significant. This conclusion is reached when evaluating the magnitude of net emission reduction in the context of local and national carbon budgets and local and national policy for achieving net zero by 2045 in Scotland and 2050 for the UK as a whole.

6.1.6 No further mitigation of operational phase GHG emissions has been proposed.

**Table 6.1: Summary of potential environment effects, mitigation and monitoring**

| Description of impact | Measures adopted as part of the project | Magnitude of impact | Sensitivity of receptor | Significance of effect | Additional mitigation measures | Residual effect | Proposed monitoring |
|---|---|---|---|---|---|---|---|
| **Construction phase** | | | | | | | |
| Direct and indirect emissions of GHGs | Sustainable worker travel and measures in the CEMP to reduce emissions from construction plant and embodied carbon in materials. | <1% of lifetime emissions: negligible | High | Negligible (not significant) | Good practice goals to seek a lean design and minimise embodied carbon, employing recognised construction carbon management frameworks such as PAS2080 | Negligible (not significant) | Construction-stage detailed design and as-build LCAs in line with carbon management frameworks |
| **Operation phase** | | | | | | | |
| Direct and indirect emissions of GHGs | Flare to manage hydrogen releases during start-up, shut-down and abnormal events.<br>Operating model of ~40% capacity factor based on expected availability and cost of low-carbon, primarily renewable electricity. | -1,279,367 $tCO_2e$/annum | High | Beneficial (significant) | n/a | Beneficial (significant) | Energy efficiency monitoring required by PPC Permit (regulated by SEPA) |

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