P.2025/61

THE STATES OF DELIBERATION
of the
ISLAND OF GUERNSEY

COMMITTEE *FOR THE* ENVIRONMENT AND INFRASTRUCTURE

PATHWAY TO NET ZERO

The States are asked to decide:

Whether, after consideration of the policy letter entitled 'Pathway to Net Zero' dated 24th March 2025 they are of the opinion:

1. To agree to adopt a seven-year cycle approach with respect to net zero, with the first period of 2025-2032 focused on the delivery of immediately achievable initiatives that are already identified in States-approved strategies and policies that deliver other benefits to islanders, whilst keeping a watching brief on global developments, and to direct the Committee *for the* Environment & Infrastructure, working with other Committees as required, to deliver the aims and objectives of the first 2025 - 2032 period, focussed on implementing and optimising already approved policies and strategies, as set out in Section 5.

2. To direct the Committee *for the* Environment & Infrastructure to revert to the States of Guernsey with an updated pathway for 2033 - 2039 no later than the end of 2032, and to rescind Resolution 4 of the policy letter "Mitigate Climate Change – States of Guernsey Climate Change Policy & Action Plan", as set out in section 6 of this policy letter, which directs that the Climate Change Action Plan is reviewed every two years.

The above Propositions have been submitted to His Majesty's Procureur for advice on any legal or constitutional implications in accordance with Rule 4(1) of the Rules of Procedure of the States of Deliberation and their Committees.

THE STATES OF DELIBERATION
of the
ISLAND OF GUERNSEY

COMMITTEE *FOR THE* ENVIRONMENT AND INFRASTRUCTURE

PATHWAY TO NET ZERO

The Presiding Officer
States of Guernsey
Royal Court House
St Peter Port

24th March 2025

Dear Sir

1 Executive Summary

1.1. Guernsey's net zero targets align with international standards and form an important part of our international obligations, but they also provide an opportunity to deliver numerous highly localised benefits to the island – in particular, significant cost savings compared with the continuation of the status quo. The States agreed these targets through both the Energy Policy[1] and the Climate Change Policy[2], and affirmed this commitment through the extension to Guernsey of the Paris Agreement[3]. In addition, various other conventions, and agreements (such as free trade agreements) refer to these obligations, and they are also integral to the island's international reputation as a sustainable finance centre[4].

1.2. Net zero means no longer adding to the total amount of greenhouse gases in the atmosphere – primarily through reducing and, where possible, eliminating emissions, and by removing the residual emissions (for example through CO_2-absorbing ecosystems) to halt their further accumulation. Net zero targets have been adopted around the world to reduce the impacts of climate change, which is driven by the accumulation of greenhouse gases in the atmosphere. Unchecked, climate change will have increasingly acute and negative economic, social, and environmental effects, including to economic growth, public finances, agriculture and food security, water security, energy security, the cost of living, health outcomes, lifestyles, and natural ecosystems. Compared with the status quo, therefore, net zero is less costly and delivers many more benefits, both globally and indeed locally.

[1] https://www.gov.gg/CHttpHandler.ashx?id=123716&p=0
[2] https://www.gov.gg/CHttpHandler.ashx?id=127345&p=0
[3] https://gov.gg/index.aspx?articleid=198887
[4] https://www.guernseyfinance.com/about/our-industry/sustainable-finance/

1.3. The bulk of Guernsey's Pathway to Net Zero over the coming years has already been agreed, and much has already been implemented. The most significant contribution to the island's decarbonisation to date has been the installation of the interconnector to France (via Jersey), known as GJ1, in 2001. The implementation of the States-agreed Electricity Strategy also plays a very significant part in the island's Pathway to Net Zero going forward. As with many initiatives that can contribute to emissions reduction, it is worth noting that the option adopted through the Electricity Strategy was significantly less costly (estimated £180m to 2050) than continuing with the status quo, as energy affordability played a determining role in its adoption.

1.4. Overall, as evidenced by Siemens report entitled Decarbonisation Pathway Options for the Island of Guernsey ("the Siemens Report", Appendix 1), the island's approach across all emissions sectors demonstrates a trend of reducing emissions. This reduction supports interim Paris Agreement targets and does much of the heavy lifting with respect to the 2050 target. The Siemens Report identifies opportunities for further emissions reductions that bring about co-benefits for islanders, in areas such as reducing air pollution, increased energy efficiency in buildings, and improvements in on-island transport, for instance. Benefits of these examples include better health outcomes and reduced health care costs, reduced energy expenditure with improved affordability and resilience, and more transport choice, convenience, and affordability. These measures are pragmatic and beneficial to progress without delay.

1.5. While our net zero targets mirror many other jurisdictions', how Guernsey reaches those targets is necessarily bespoke to the island's circumstances and resources. This policy letter sets out a realistic, practical, and affordable pathway towards those targets in a way that achieves significant wider benefits as well. Indeed, none of the proposals in this pathway are recommended for their emissions impact alone: only proposals that have wider advantages, such as economic opportunities and benefits for the island or that improve the quality of life for those living here, have been recommended through this pathway.

1.6. Guernsey is already on course to meet its 2030 target – a reduction of 57% by 2030 on 1990 greenhouse gas emissions. However, the current trajectory of emissions reductions is not projected to reach net zero by 2050. Without additional initiatives, emissions are currently estimated to reduce by 66% (from 300ktCO_2e[5] to 101ktCO_2e), so that outstanding 34% is the focus of this policy letter.

1.7. The Siemens Report also evidences that, in common with other jurisdictions, for Guernsey to reach net zero by 2050 it will require additional means that are not yet developed or ready for adoption, such as carbon capture technology. As is the case globally, more solutions that require further innovation to support net zero ambition will be needed. There is significant international focus on and investment in the development of such solutions, but this pathway focuses on what is achievable for Guernsey at this point in time and is therefore transparent that none of the potential pathways take the island quite to net zero, even though they do get very close to that

[5] ktCO_2e stands for "kilo tonnes of carbon dioxide equivalent" and therefore refers to all greenhouse gases not just carbon dioxide.

target. It is an eminently reasonable assumption that the means by which to reach net zero will be developed in the intervening years. While Guernsey should be open and adaptable to emerging solutions and opportunities during the global decarbonisation transition, for the time being it makes sense to focus on what we can do now.

1.8. In carrying out the States' Government Work Plan resolution[6] and assessing the options, the Committee *for the* Environment and Infrastructure ("the Committee") chose to prioritise reducing emissions in areas where this would result in additional positive outcomes (i.e. co-benefits) such as economic benefits and opportunities, improved affordability, greater convenience, healthier lifestyles, clean air, clear seawaters, biodiversity net gain and access to nature. The proposed approach maximises these benefits, whilst aligning with net zero outcomes.

1.9. Three pathways have been modelled. These are the baseline pathway (the current trajectory, assuming no additional initiatives), a moderate ambition pathway and a high ambition pathway. The Siemens Report sets out a shortlist of 23 initiatives that will accelerate emissions reductions and provide other benefits. All the pathways meet the interim 2030 emissions target. The baseline pathway is estimated to result in 101ktCO_2e emissions by 2050, the moderate pathway 27ktCO_2e and the ambitious pathway 12ktCO_2e.

1.10. Throughout the development of the Siemens Report, key stakeholders have played an important role in providing evidence to support the technical assessment of emissions across all sectors and providing potential solutions to resolve net zero emissions by 2050. The Siemens Report was commissioned by the States of Guernsey in January 2024, with workshops held in the spring and summer with stakeholders who had expertise across emissions sectors and could explore realistic and effective initiatives tailored to the unique characteristics and constraints of Guernsey. The Energy Partnership played a key role, and stakeholders were brought together to work collaboratively to develop the Siemens Report as well as the strategic approach.

1.11. The Committee considered proposing the adoption of either the moderate or the ambitious pathway. However, given that the options will continue to evolve, for example because of technological innovation, the Committee instead recommends an iterative approach, using seven-year periods and ongoing reviews that will enable Guernsey to hone its priorities and continuously adopt and adapt to the best options that become available as they develop. Focusing on shorter timeframes will be more pragmatic and manageable. It is a credible approach that aligns well with the increasing levels of ambition in the Paris Agreement and achieves the most beneficial outcomes for the island.

1.12. A key driver of this approach is considering what can be achieved in the short-term that brings about co-benefits for islanders, such as increased energy efficiency of homes, reduced energy expenditure for individual households and businesses and for

[6] To direct the Committee for the Environment & Infrastructure to prioritise its resources to discharge its responsibilities in accordance with its committee work plan in Appendix 7 that translates the requirements of the Government Work Plan where they engage its mandate, noting the funding provision in Appendix 10.

Guernsey Electricity, more choice and convenience in transport, cost of living improvements, healthier lifestyles, circular economic growth, and the commercial opportunities.

1.13. The States of Guernsey can facilitate and support the local energy transition as the global economy moves away from fossil fuels. Decarbonisation typically creates efficiencies and supports new low-emissions products and services. Government energy policy is accommodating of and agile enough to meet changing needs and demands. The States of Guernsey's role is to facilitate the energy transition, not to fund it.

1.14. The first seven-year phase of net zero pathway actions ("Phase 1") includes development of the following initiatives that are taken from the Siemens Report and which focus on the highest emissions sectors – buildings and transport:

- Review of building control to support improvements in building standards (note the UK's Future Homes Standard);
- Introduction of Energy Performance Certificates;
- Ongoing reviews and development of agriculture and the dairy sector;
- The piloting of smaller scale deployable solutions, with success scaled up, for decarbonisation of heating (alternative, low carbon, and hybrid fuels);
- Improved infrastructure for and initiatives to support a wider range of transport options, including more choice relating to more space-efficient non-motorised modes, shared mobility such as car clubs and public hire-per-journey bikes, improved public transport, EV charging infrastructure, transport hubs, and congestion reduction.

1.15. The following actions are also proposed for Phase 1:

- The States of Guernsey leading by example by reporting on its organisational and operational emissions and setting out its own Net Zero Action Plan, with a focus on improved efficiency and cost reduction;
- The establishment of a Net Zero Action Forum to facilitate information sharing between government, businesses and other stakeholders, and develop best practice;
- A review of data gaps to establish what is missing;
- Continuing to keep a watching brief on UK Net Zero and Jet Zero strategies;
- A review of existing environmental taxes to optimise alignment between fiscal and wider objectives;
- Alignment with the principles of a just transition.

1.16. The Siemens Report was developed around the principle of not limiting or drastically changing life in Guernsey, instead adopting iterative improvements. The island is already decarbonising at a reasonable rate in order to achieve interim carbon emissions and climate change target reductions. A smooth downward curve of emissions reductions allows for existing sources of emissions to be replaced by more sustainable technologies and practices over time, in a way that is easily manageable

and affordable in the short-term, whilst delivering longer-term savings.

1.17. The Phase 1 Action Plan will be delivered throughout the next political term and will include identification of areas that require further development. That includes but may not be limited to alternative and renewable fuel options, legislative levers, incentivisation, and systemic solutions for the community to work collaboratively with the States of Guernsey to drive uptake of on-island solutions.

1.18. The States of Guernsey will continue to facilitate approaches made by private businesses and third parties that can provide renewable energy, low carbon fuel and other sustainability solutions for the island. The Net Zero Forum will facilitate co-operation and communication between government and individuals, businesses and organisations, supporting the realisation of the significant economic opportunities associated with net zero. Wider benefits include healthier lifestyles, reducing the healthcare burden, improving transport infrastructure to give people more choice in how they travel on-island, and improvements to the cost of living. By working systemically with established groups, business and organisations, the States of Guernsey can continue to achieve greenhouse gas ("GHG") emissions reductions in an economically responsible way.

2. Introduction

2.1. Guernsey is already experiencing the impacts of climate change through localised sea level rise around the Channel Islands and more extreme weather – including more intense rainfall, stronger storms, greater frequency of storm damage, flooding, hotter summers, and milder winters – among other effects, such as increasing numbers of invasive non-native species.

2.2. With increased frequency of heatwaves, more violent storms, higher tides and weather events, Guernsey must continue to focus on climate change resilience in addition to continuing its course to decarbonise island life. The difficulty and cost of trying to adapt our way of life to temperature increases above 1.5°C and up to 4°C[7] would be acute. While Guernsey obviously cannot contain global heating through the island's efforts alone, it is important, as a mature and responsible jurisdiction that depends economically on a sound international reputation, that we play our part in the global effort. Net zero and decarbonisation initiatives can also bring about co-benefits for islanders. Improving home energy efficiency may reduce household bills and increased sustainable travel options can improve health and wellbeing.

2.3. Climate action has co-benefits that can have a positive impact on not just our own daily lives but also for the communities we are connected to through the work of the Overseas Aid & Development Commission, trade agreements, as a global finance centre as well as the island's importance and value for heritage, culture, sport and

[7] Climate change affects all regions around the world. Polar ice shields are melting and the sea is rising. Climate change is a very serious threat, and its consequences impact many different aspects of our lives. The European Commission published an accessible list of climate change's main consequences: https://climate.ec.europa.eu/climate-change/consequences-climate-change_en

tourism.

2.4. Achieving net zero will require some co-ordinated, incremental changes from government, businesses, and individuals.

2.5. Between 1990 and 2022, Guernsey reduced its emissions by 46.8% from 561ktCO_2e to 300ktCO_2e. This level of reduction was largely achieved by switching to imported electricity supply. Since 2001, Guernsey has benefitted from interconnection, allowing import of energy from Europe, via Jersey[8]. Before this, Guernsey relied solely on its fossil-fuelled power station for all electricity.

2.6. Between 1990 and 2022, other contributions to Guernsey's emissions reductions include the reduced the use of fossil fuels by residences, businesses (including industrial processes) and road transport vehicles, and the reduction of waste going to landfill.

2.7. The UK and other Crown Dependencies have also committed to net zero targets. The Government of Jersey is taking proactive climate action and regularly report and update on progress. Between 1990 and 2022, emissions in Jersey have decreased by 47%.

	Reduction Achieved	Reduction Targets		
	2022	2030	2035	2050
The 'Baseline Period' uses 1990 for carbon dioxide, methane, and nitrous oxide and 1995 for hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.				
UK	50%	68%	81%	NET ZERO
Guernsey	46.8%	57%	N/A	
Jersey	47%	68%	78%	
Isle of Man	-1.2%	35%	45%	

FIGURE 1: COMPARISON OF GREENHOUSE GAS EMISSION REDUCTION

2.8. Guernsey is in an advantageous position and can pragmatically accelerate ambition to achieve the maximum impact within our means. Out of the 23 initiatives set out in the Siemens Report, most of them could be implemented at a smaller scale initially and expanded depending on outcomes, with opportunities for private funding, investment, not-for-profit solutions, and other commercial opportunities. The Pathway to Net Zero should stimulate more opportunities to be presented to the States of Guernsey, who are open for engagement and ready to facilitate and develop solutions. A number of such proposals relating to innovative renewable energy solutions are already being explored and progressed. This is testament to the accessibility and agility of Guernsey's small government. The States' Energy and

[8] The Channel Islands Electricity Grid (CIEG) is the joint venture company set up in 1998 between Guernsey Electricity and Jersey Electricity to operate and manage the subsea cables connecting both Islands to the European grid and which maintains a supply agreement with Electricité de France.

Climate Change Team have worked in a facilitative way with the energy sector in particular since the 2020 Energy Policy and have experience in working with key stakeholder groups through the Energy Partnership [9] as well as working across government departments and services.

2.9. The States of Guernsey Electricity Strategy 2023 ("the Electricity Strategy") provides the basis for further decarbonisation. However, the Committee has also considered how the wider energy sector can support decarbonisation whilst keeping costs as low as possible, reducing cost pressures on the electricity system in the short to medium term. There will remain areas where emissions are harder to abate, so government will need to keep apprised of innovation and technology that is still being developed to identify what works best for Guernsey. The approach the Committee therefore takes is one that enables collaborative working with the energy providers, to understand their decarbonisation plans and see where the States of Guernsey can work with them. This is quite different from a specific penalty-based approach, such as boiler bans, which is in place in other jurisdictions: the Committee does not consider that this kind of penalty-based approach would be appropriate for Guernsey. Rather than banning existing technology that could in fact work with lower-carbon fuels, the Committee considers that these alternative fuels have a potentially important role in decarbonisation locally and is keen to work with providers to support their use in ways that make the most efficient use of resources, existing technology and infrastructure.

3. Strategic Context and Background

Climate Change Policy and Government Work Plan

3.1. In 2020 the States of Guernsey approved the States of Guernsey Climate Change Policy and Action Plan[10] ("the Climate Change Policy") which set the target for net zero by 2050, with an interim target of 57% reduction on 1990 levels by 2030. The policy directed work be undertaken to extend the Paris Agreement to Guernsey, which was also a Government Work Plan priority as part of a requirement to align with global international agreements. The principal requirement of the Paris Agreement is reporting on progress, and this should be supported by demonstrating how progress will be made. The Paris Agreement was extended to Guernsey in December 2023 and the Pathway to Net Zero work has been developed to discharge the requirement for a plan and projection of emissions. This work also supersedes the action plan that accompanied the policy.

3.2. The States of Guernsey's Energy Policy 2020-2050[11] ("the Energy Policy") was also adopted in 2020 and established six objectives, including decarbonisation of the energy sector. Guernsey's energy policy is energy agnostic and the development of

[9] The Energy Partnership was established to develop the Energy Policy 2020 – 2050. It is made up of stakeholders from local energy and fuel supplier organisations. The group come together to review government policy and maintain relationships with government for support during the energy transition to low carbon and renewable energy. The expertise and knowledge shared is beneficial and encourages healthy competition.

[10] https://www.gov.gg/CHttpHandler.ashx?id=127345&p=0

[11] https://www.gov.gg/CHttpHandler.ashx?id=123716&p=0

the Pathway to Net Zero has considered ways that the whole energy sector can decarbonise. This aligns with the island's Electricity Strategy, which evidenced that a decarbonised approach offered a £180m reduction in long run costs across 27 years to the electricity system compared with the status quo. The Electricity Strategy has formed part of the baseline assessment for the Pathway to Net Zero; however, the latter has looked at ways the wider energy sector could support the Electricity Strategy and potentially provide a more cost-optimal approach for the island as a whole.

3.3. The Energy Policy, the Climate Change Policy and the Electricity Strategy do not lock the island into any set solutions for 2050. Far from it: in fact, the policy and resource already available is facilitative and able to adapt to emerging and innovative solutions, driven predominantly by ensuring energy security, resilience, and affordability. This is innovation is already underway, but much of this work is not publicised due to commercial sensitivities. The energy industry locally, as internationally, is working through a successful commercial transition to support climate goals and net zero ambitions. Work is ongoing by the Committee *for* Economic Development to ensure energy market remains competitive, encourages consumer choice and affordability.

3.4. The development of the Pathway to Net Zero and the implementation of the Paris Agreement was prioritised by the States in the Government Work Plan. It has been identified as part of an obligatory action supporting free trade agreements and other international obligations. It is important to progress this workstream to support the island's economy, both through ensuring compliance for international trade agreements and assisting supporting growth of the local but globally facing financial services sector.

3.5. The extension of the Paris Agreement to Guernsey in December 2023 means that the island's emissions will be reported under the UK's Nationally Determined Contribution. However, Guernsey retains the ability to set its own targets, policies and levels of ambition. The Government Work Plan also prioritises the marine spatial plan, which has potential to further inform future pathways through a blue carbon assessment.

The Paris Agreement

3.6. The Paris Agreement is an international treaty for climate change. Its long-term temperature goal is to keep the rise in mean global temperature well below 2°C above pre-industrial levels and preferably limit the increase to no more than 1.5°C. To achieve this the world needs to rapidly decarbonise.

3.7. The Paris Agreement was adopted at the UN's 21st Conference of Parties (COP21) in Paris in 2015 and came into force on 4th November 2016. The agreement allows for each country to determine its own plan with regular reporting to mitigate climate change. By signing up to the Paris Agreement, all parties agree that global average temperature increase should be limited to well below 2°C above pre-industrial levels by the middle of the century, preferably limiting warming to no more than 1.5°C. There are no specific requirements of the emission reduction targets other than that they should go further than previous targets and reflect a party's highest possible ambition.

Unlike the preceding Kyoto Protocol and Doha Amendment, there are no legally binding requirements for countries to meet their targets, but parties are required to maintain successive Nationally Determined Contributions, of maximum ambition, and to report on progress in implementing them.

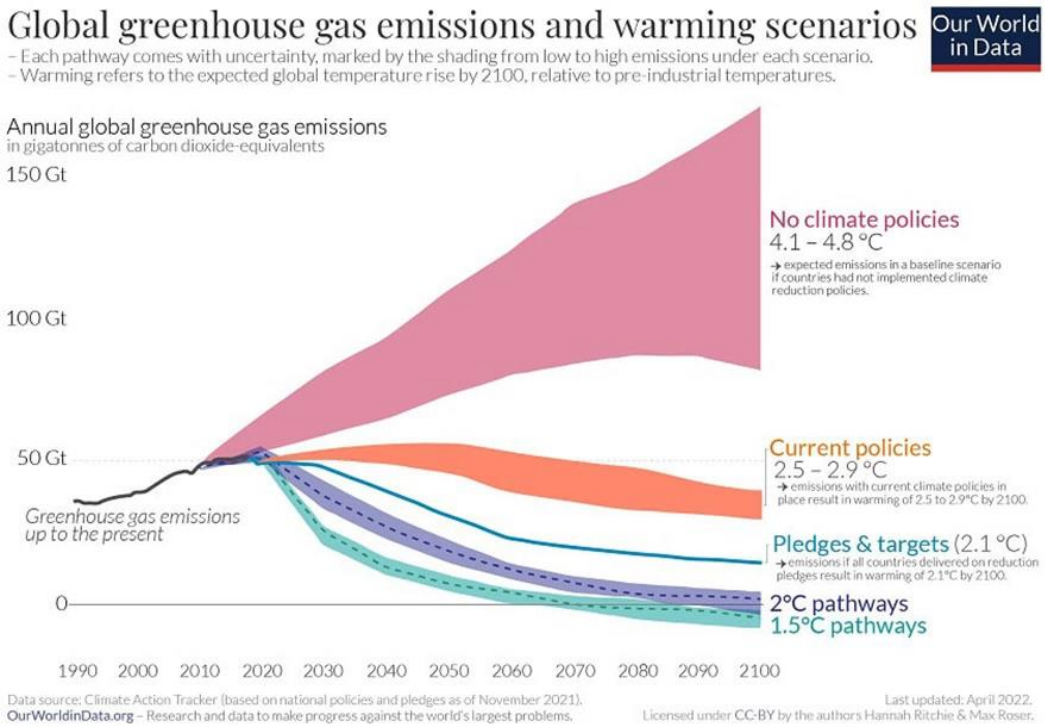

FIGURE 2: GLOBAL GREENHOUSE GAS EMISSIONS AND WARMING SCENARIOS

3.8. Figure 2 shows how global emissions will need to be reduced in order to reach the net zero target. Failing to implement any climate action policies would lead to catastrophic temperature rises [12]. Current modelling based on the climate policies adopted internationally to date predicts global temperature rises of around 2.8°C by 2100[13]; however, the effects of even this more moderate temperature increase would still be acutely negative and disruptive. With more focused and efficient emission reduction efforts, the path to keep warming below 2°C can be achieved. As 2050 approaches, emissions that cannot be abated with today's technology will become easier to reduce or eliminate thanks to continued innovation and advances.

3.9. 98% of all anthropogenic GHG emissions are produced by countries that are signatories to the Paris Agreement. The Intergovernmental Panel on Climate Change (IPCC) is a part of the United Nations that assesses the science related to climate change. In 2021 the IPCC published its sixth Assessment Report (AR6) Climate Change 2021: The Physical Science[14].

3.10. The report reinforces the need to reach net zero in carbon dioxide emissions and

[12] https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/
[13] IPCC Climate Change Synthesis Report – Summary for Policy Makers. Based on NDC's as received by 2021 - https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf - 3- paragraph A4.3
[14] https://www.ipcc.ch/assessment-report/ar6/

strong reductions in other greenhouse gas emissions. It states that all emissions must be halved by 2030, and net zero must be achieved by 2050 at the latest in order to avoid the most catastrophic effects of climate change. It also found that global surface temperature will continue to increase until at least the mid-century under all emissions scenarios considered. Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide and other greenhouse gas emissions occur in the coming decades.

National Targets and Commitments for Net Zero

3.11. More than 130 countries have now set or are considering a target of reducing emissions to net zero, including China, the EU, and the USA. A summary of countries' net zero target dates is presented in Figure 3. The USA has started the process of withdrawal from the Paris Agreement, which takes one year. However, when the USA commenced the withdrawal process from the Paris Agreement during the last Trump presidency, the country's emissions remained stable, with a slight overall trend downwards, over the four-year term. Economists anticipate that the USA's carbon emissions will continue on a downward trajectory even after the country's withdrawal from the Paris Agreement as the economic imperatives support continued decarbonisation.

3.12. The States of Guernsey agreed, through the Climate Change Policy, targets for a 57% reduction of carbon dioxide equivalent (CO_2e) emissions on 1990 levels by 2030 and net zero by 2050. Through the extension of the Paris Agreement to Guernsey, reporting is covered under the UKS NDC reporting, and the island's annual GHG inventory forms part of the UK's overall reported emissions and targets. Officers have been involved in the process of forming the UK's first biennial[15] report which includes specific reference to the performance of the Crown Dependencies and Overseas Territories to which the Paris Agreement has been extended.

3.13. Guernsey must input into three sections of the UK's NDC report: Greenhouse Gas Inventory, Greenhouse Gas Projections and Policies and Measures. The States of Guernsey already collects the GHG inventory information required to report under the Paris Agreement, most of which is published through the annual Greenhouse Gas Bulletin[16] which is compiled by Aether[17]. The work undertaken in the Siemens Report provides projections based on a number of scenarios and can be used, along with the policy approach, to fulfil this requirement. Officers from across the States have provided information on policies and measures that are delivering climate impact, whether directly or indirectly.

[15] https://www.gov.uk/government/publications/uk-biennial-transparency-report-to-the-un-framework-convention-on-climate-change-2024/uks-first-biennial-transparency-report-submitted-to-the-un-framework-convention-on-climate-change-under-the-paris-agreement
[16] https://www.gov.gg/article/120766/Search-archive-of-statistical-publications#selectednavItem152476
[17] https://aether-uk.com/

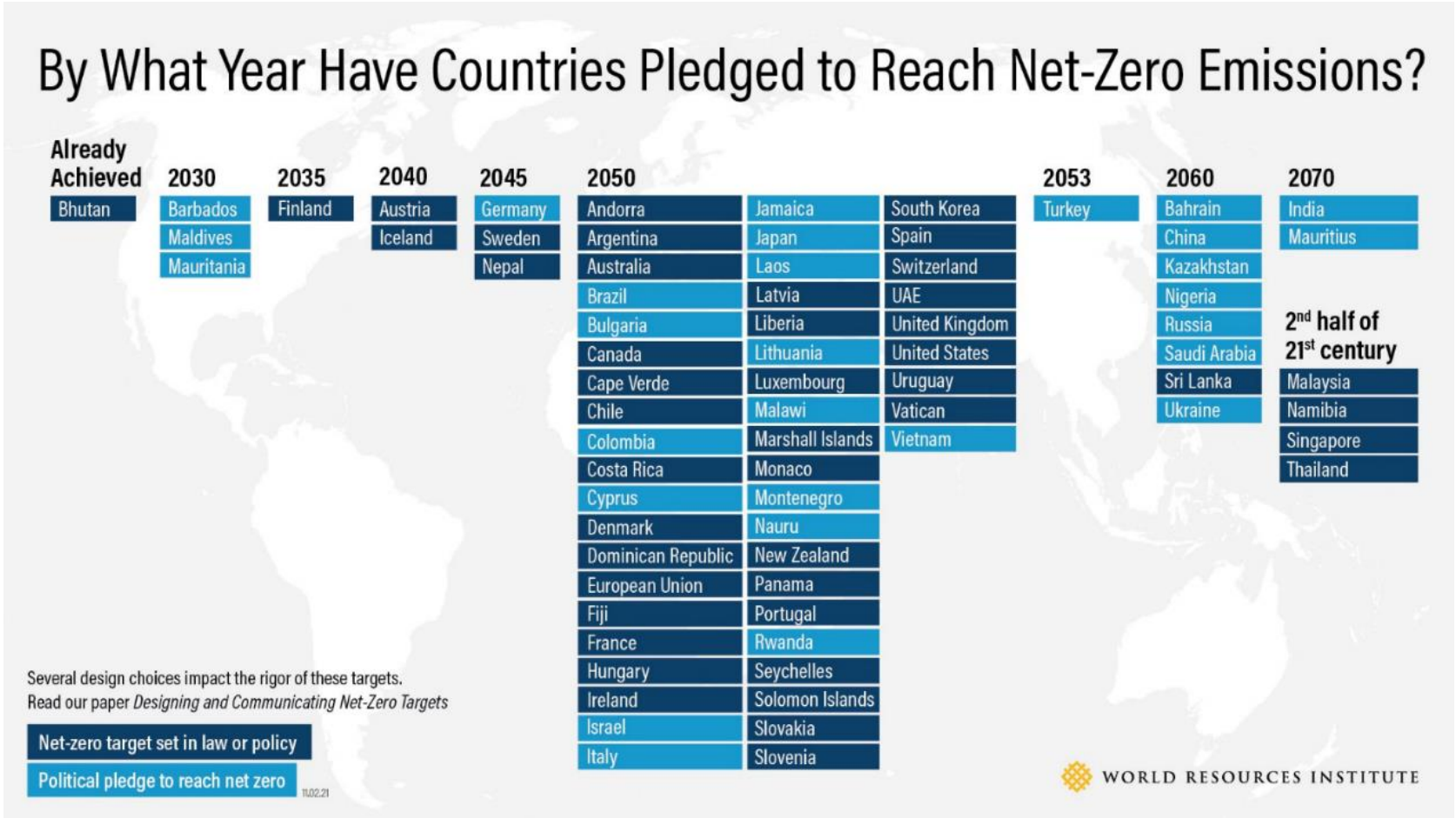

FIGURE 3: YEAR OF NET ZERO PLEDGES BY COUNTRIES

3.14. The policy for net zero in the UK is The Climate Change Act 2008. This was the world's first legally binding net zero target. It commits the UK to net zero emissions by 2050. It also has an interim target of a 78% reduction of GHG emissions from 1990 levels by 2035. It sets five-yearly carbon budgets for each sector of the economy that the independent Climate Change Committee ("CCC") oversees.

3.15. The EU aims to be climate neutral by 2050. To do this, the EU nations must develop national long-term strategies for how they plan to achieve the GHG reductions to meet Paris Agreement commitments. The EU has also committed to reduce net GHG emissions by 55% from 1990 levels by 2030.

3.16. Governments, organisations, and local councils all over the world have made net zero pledges, which are commitments to meet net zero and are normally accompanied by a set target date. Guernsey is aligned with the United Kingdom as per the Climate Change Policy 2020-2050 and by ratification and extension of the Paris Agreement in December 2023. Locally, support for action to meet net zero emissions targets goes hand in hand with safeguarding and protecting the island's clean air, seawaters, and natural environment. There is a strong sense that climate action and net zero initiatives will deliver for Guernsey at local level, as well as maintaining and strengthening wider trade and economic benefits. The Siemens Report confirms that reaching net zero will be a challenge globally, and that action now needs to have a measurable impact.

3.17. There are, however, potential discrepancies between the aspirations set out in a pledge and the effectiveness of the action agreed to meet those targets. The Energy and Climate Change Unit and the University of Oxford jointly published a paper called Taking Stock: A global assessment of net zero targets[18], in March 2021. From its research, it identified that only 20% of the targets they studied met a set of basic robustness criteria. Net Zero Tracker monitors and publishes global commitments to reach net zero and has also included analysis of action by the biggest companies[19]. The Net Zero Tracker provides an overview of the 2,000 largest publicly-traded companies in the world by revenue.

What is Net Zero?

3.18. The term net zero applies to a situation where global greenhouse gas emissions from human activity are in balance with emissions reductions. At net zero, carbon dioxide emissions are still generated, but an equal amount of carbon dioxide is removed from the atmosphere as is released into it, resulting in zero increase in net emissions.

3.19. There is an imbalance between the amount of anthropogenic GHG emissions and the amount humans remove from the atmosphere. There is ongoing research into how nature sequesters carbon and also development of technology to replicate this, and to provide long-term carbon emissions removal systems and solutions.

3.20. There are a number of different terms that are often used when considering climate

[18] https://racetozero.unfccc.int/wp-content/uploads/2021/06/ECIU-Oxford_Taking_Stock.pdf
[19] https://zerotracker.net/

change. 'Carbon neutral' is when the amount of carbon dioxide emitted is calculated and is compensated with a form of removal of that same amount. "Climate neutral" is when an actor's activities result in no net effect on the climate system including regional/local biogeographical effects of human activities including changing albedo (reflectiveness of a surface). This includes balancing the residual emissions with emission removal. 'Absolute zero' or 'true zero' is where no GHG activities are attributable to an actor's activities. Under this definition, no offsets or balancing of residual emissions with removals are used.

3.21. A "pathway to net zero" (which is the outcome that Guernsey has committed to) means setting out how net carbon emissions can be reduced to zero following a trajectory over time. Like many other jurisdictions, Guernsey's target of net zero is tied to the 2050 (or sooner) deadline and aligns with avoiding global temperature increases above 1.5°C.

3.22. Net zero can be achieved in many ways including through:

- Energy demand reduction;
- Affordable low carbon energy;
- Energy efficiency;
- A circular economy approach to waste;
- Adopting sustainability principles (such as the Energy Hierarchy, the Waste Hierarchy, and the Transport Hierarchy).

3.23. initiatives that contribute to net zero can lead to:

- Economic growth;
- Improved health and wellbeing;
- Lower pollution;
- Less expenditure on energy.

3.24. For a net zero approach to be robust for any jurisdiction it must:

Support the aims of the Paris Agreement	**Focus on immediate action**	**Be inclusive of all scopes**	**Not use offsets to claim net zero**
It must utilise direct decarbonisation and careful use of carbon removals.	It should include an interim target to ensure that it is on track for reaching the target of net zero.	All scopes[20] must be included. Scope 3 reduction is mandatory to achieve a robust net zero.	It must utilise direct decarbonisation and use science-based targets.

FIGURE 4: REQUIREMENTS OF A ROBUST NET ZERO APPROACH

[20]See section 7.3 (p 66 – 71) of the Climate Change Policy (https://gov.gg/CHttpHandler.ashx?id=127345&p=0) for more information.

The 'Greenhouse Effect'

3.25. The temperature of the planet is increasing due to the greenhouse effect, with anthropogenic emissions from fossil fuels bolstering what is known as global warming, or global heating. Global warming is the long-term heating of the Earth's surface since the pre-industrial period due to human activities. Global warming is a part of climate change.

3.26. Sunlight passes through the Earth's atmosphere and heats the Earth's surface. The Earth's surface radiates heat and some escapes into space. GHGs absorb some heat and send it back to Earth. As GHGs build up, more heat is sent back and the Earth's temperature rests. GHGs include carbon dioxide, methane, nitrous oxide, and fluorinated gases. These can occur naturally but are produced in large quantities by various human activities such as: burning fossil fuels (carbon stored over millions of years by the earth's natural processes), agriculture, and the release of gases used as refrigerants and solvents. Reducing all anthropogenic GHG emissions to zero on the timescale needed would be very difficult. This is why a net zero approach has been recommended globally.

3.27. Human activities are estimated to have caused approximately 1.2°C [21] of global warming above pre-industrial levels (see Figure 5). Global warming is likely to reach 1.5°C between 2030 and 2050 if it continues to increase at the current rate.

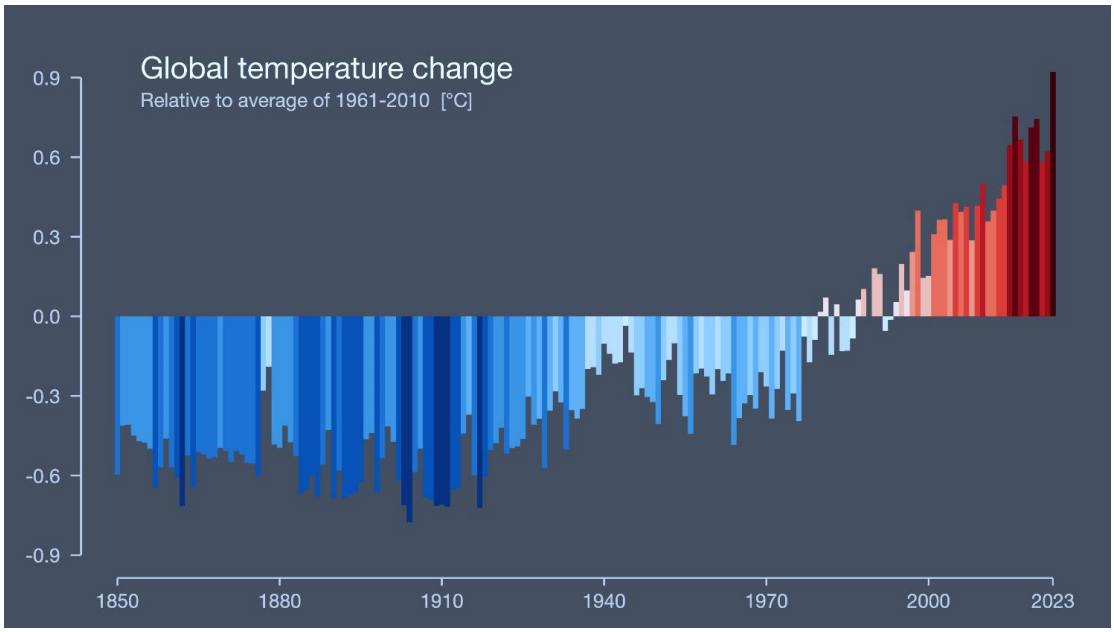

FIGURE 5: GLOBAL TEMPERATURE CHANGE SINCE 1850[22]

[21] https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2025/2024-record-breaking-watershed-year-for-global-climate

[22] https://showyourstripes.info/c/globe

Carbon offset

3.28. To achieve net zero, carbon offset, and carbon removal will be necessary. Carbon offset is a way for individuals or companies to compensate for the CO_2e emissions they produce by investing in projects that avoid an equivalent amount of CO_2e into the atmosphere. For example, if one metric tonne of CO_2e is emitted, one metric tonne of CO_2e is avoided or removed elsewhere. Additionality is a key component of a carbon offset project, meaning that the project should provide additional reductions above what would have happened if the project hadn't been undertaken. Examples of offsetting investments can include:

- Renewable energy projects;
- Biogas production;
- Water treatment;
- Energy efficiency.

Carbon removal and nature-based solutions

3.29. Carbon removal is the process of capturing carbon dioxide CO_2 from the atmosphere and securely storing it or using it in a way that it is permanently removed, e.g. if one metric tonne of CO_2 is emitted, one metric tonne of CO_2 is removed completely from the atmosphere. For a carbon removal offset project, this removal of CO_2 would not have happened without the carbon removal project taking place. Examples of carbon removal offset projects include:

- Afforestation;
- Wetland restoration;
- Support for sustainable agriculture projects.

Emerging innovation and technology

3.30. Direct Air Capture is a form of carbon removal that uses processes to capture carbon dioxide directly from the air and then permanently stores it. Currently, this form of removal exists on a small scale.

3.31. Another carbon removal is Bioenergy with Carbon Capture and storage (BECCS). This is where biomass is burned to produce energy, and the resultant carbon dioxide is stored. Currently there needs to be more support for these technologies and experience in large-scale applications is lacking. There is also a challenge with carbon removals in ensuring their long-term storage. For example, if trees are planted, there must be the assurance that they will not be cut down in future years.

4. Development of the Net Zero Pathway

4.1. The States prioritised the development of the Pathway to Net Zero through the Government Work Plan to comply with international obligations. After a delay caused by the funding freeze in 2023, the Committee commissioned a technical analysis of the pathway options through Siemens, working with Aether, to inform the

development of the island's strategy.

4.2. The work undertaken was to deliver an annualised forecast of emissions, outline the options available for emissions reduction, develop options into three viable pathways (baseline, moderate and ambitious) and identify the broader advantages of any initiatives[23]. The baseline pathway was an assessment of the expected emissions based on the ongoing implementation of States approved policies, the moderate pathway aimed to deliver net zero emissions by 2050 and the ambitious pathway aimed to deliver an accelerated net zero pathway. All initiatives were available for consideration including technological, fiscal, policy, incentivisation and changing habits. The initiatives had to be credible for delivery in Guernsey and be accompanied by the potential impact of each initiative. The approach is therefore focussed on maintaining and enhancing the island's way of life and recognises the need for off-island travel.

4.3. After an initial assessment of the baseline by Siemens and Aether, there were two main conclusions that influenced the ongoing development of the report. The first was that in implementing existing actions and policies, Guernsey is on target to meet the 2030 target of 57% reduction of greenhouse gas emissions on 1990 levels. This is a positive conclusion and one that illustrates that the island's existing and ongoing measures are proving effective. The second was that achieving net zero by 2050, using existing technologies and the principle of maintaining Guernsey's way of life, was unlikely to be possible.

4.4. The Committee therefore agreed to an amended approach to the moderate and ambitious pathways. The moderate pathway now considers initiatives that are established, mature and common practice in other jurisdictions and suitable for Guernsey, noting it does not meet net zero by 2050. The ambitious pathway aims to push the boundaries of the initiatives in the moderate pathway in terms of scale, penetration, and performance, whilst considering additional initiatives that may be considered less proven or more 'cutting edge' in their field. However, the ambitious pathway also falls a little short of net zero by 2050. This clearly illustrates the challenges of meeting the net zero target, and the need for an approach that acknowledges that not all the solutions are currently available.

Siemens Report

4.5. Siemens, working with Aether, undertook an exercise to forecast Guernsey's greenhouse gas emissions out to 2050. This looked at three pathway scenarios:

- Baseline pathway;
- Moderate pathway;
- Ambitious pathway.

4.6. The decarbonisation strategy approach was based on facilitating continued trade, stimulating economic growth, and enhancing Guernsey's reputation by aligning with

[23] These are referred to as interventions in the Siemens Report.

the targets set by the Paris Agreement, whilst also improving quality of life for islanders. Furthermore, it should be economically viable, ensuring that financial responsibility does not solely rest on the government. It should promote a circular economy, which encourages the reuse of resources. It should unlock broader societal advantages, including health improvements and environmental enhancements.

4.7. The baseline pathway was modelled first. It looks at the historic emissions reduction from 1990 and then forecasts the island's emissions to 2050 based on existing policy measures. Between 1990 and 2022, Guernsey's emissions reduced from 561ktCO_2e to 300ktCO_2e: a 46.8% reduction. In absolute terms, the largest reductions occurred due to decarbonisation of electricity supply (-122ktCO_2e), reduced use of fossil-fuels for residential, commercial and industrial combustion (-79.2ktCO_2e), reduced use of petrol and diesel for road vehicle transport (-50.4ktCO_2e), and reduced use of landfill for waste (-27.8ktCO_2e). Over the same period, emissions increased in connection with agricultural activity (+5.9ktCO_2e) and use of F-Gases (+13.8ktCO_2e).

4.8. Under the baseline pathway, emissions are estimated to reduce by 66% to 2050, and to meet the 2030 interim target of 57% reduction on 1990 levels – see Figure 6.

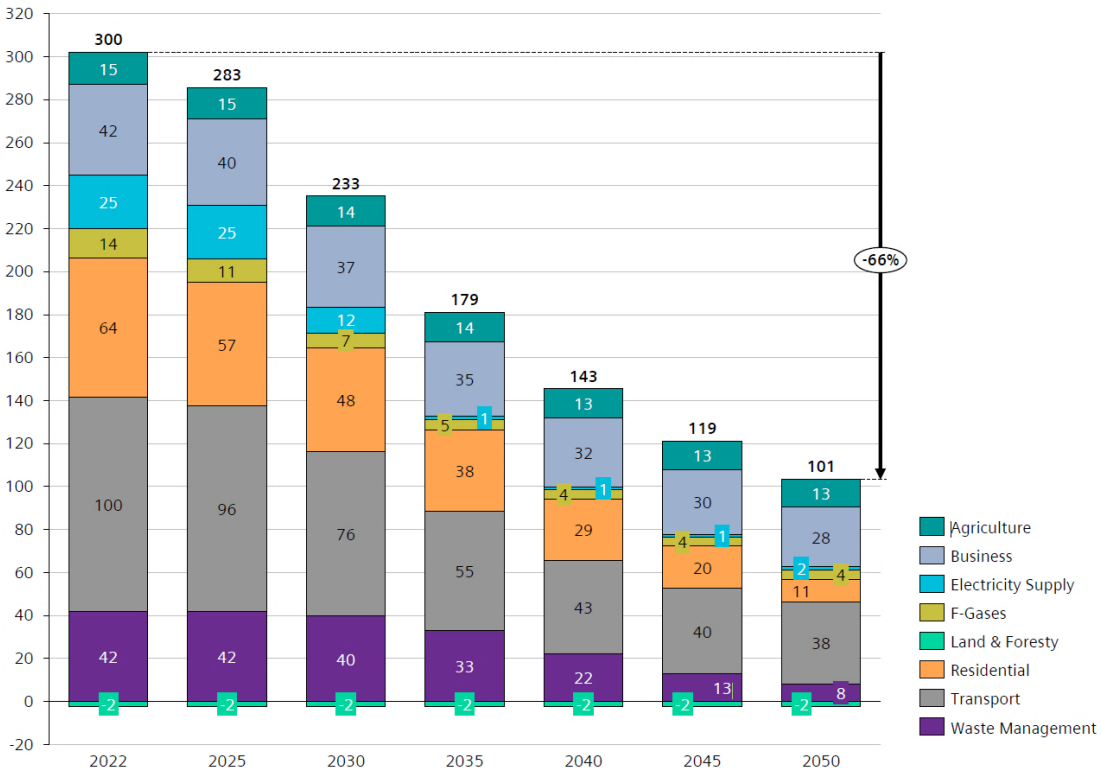

FIGURE 6: PROJECTED EMISSIONS FOR THE BASELINE PATHWAY (2022 – 2050) - THE SIEMENS REPORT

4.9. Workshops were then held with targeted stakeholders from across the States and wider industry (all sectors) to discuss potential initiatives that could support decarbonisation. This ensured that local considerations were factored into the development of initiatives. The workshops provided a review on options already under consideration. Various stakeholder groups, including States of Guernsey officers, the Energy Partnership, local businesses and travel groups, engaged with Siemens and Aether to develop the initiatives and a network of additional stakeholders emerged

from locals who were working in areas focusing on sustainability and local climate action who were keen to share insights. Confidential previews of the baseline, pathways and initiatives were shared at several development stages of the development of the report.

4.10. The moderate pathway considers initiatives that are established, mature and common practice in other jurisdictions, and suitable for Guernsey. In comparison to the baseline pathway that produces 101ktCO_2e of emissions in 2050, the level of emissions in a moderate pathway could be reduced to 27ktCO_2e in 2050, a 74ktCO_2e reduction. A number of initiatives across the sectors have been considered and modelled in the moderate pathway to accelerate Guernsey's decarbonisation.

4.11. In the moderate pathway, the electricity supply and waste management sectors do not reduce GHG emissions any faster or further than in the baseline pathway. This is because the full implementation of Guernsey's electricity strategy is assumed in both pathways, and an initiative to locally produce renewable fuel from organic waste would have the effect of increasing and offsetting emissions in the GHG inventory. Overall, the moderate pathway can achieve a 91% reduction in GHG emissions by 2050 compared to 2022 levels – see Figure 7.

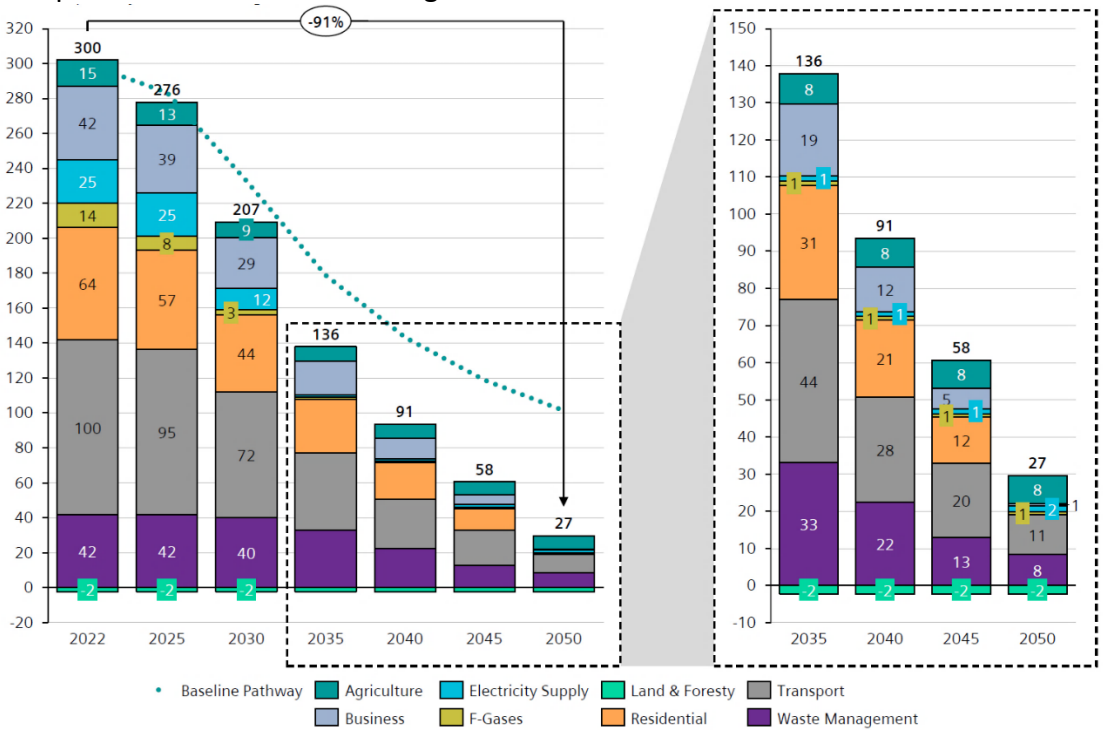

FIGURE 7: MODERATE PATHWAY - THE SIEMENS REPORT

4.12. The ambitious pathway aims to push the boundaries of the initiatives in the moderate pathway in terms of scale, penetration, and performance, whilst considering additional initiatives that may be considered less proven or more 'cutting edge' in their field. In comparison to the moderate pathway that produces 27ktCO_2e of emissions in 2050, the level of emissions in an ambitious pathway could be reduced to 12ktCO_2e in 2050, a further 15ktCO_2e reduction.

4.13. Mostly, the ambitious pathway proposes several new initiatives regarding off-Island travel, energy from waste and use of carbon capture technologies. Overall, the ambitious pathway can achieve a 96% reduction in GHG emissions by 2050 compared to 2022 and an 56% reduction compared to the moderate pathway's 27 $ktCO_2e$ emissions in 2050 – See Figure 8.

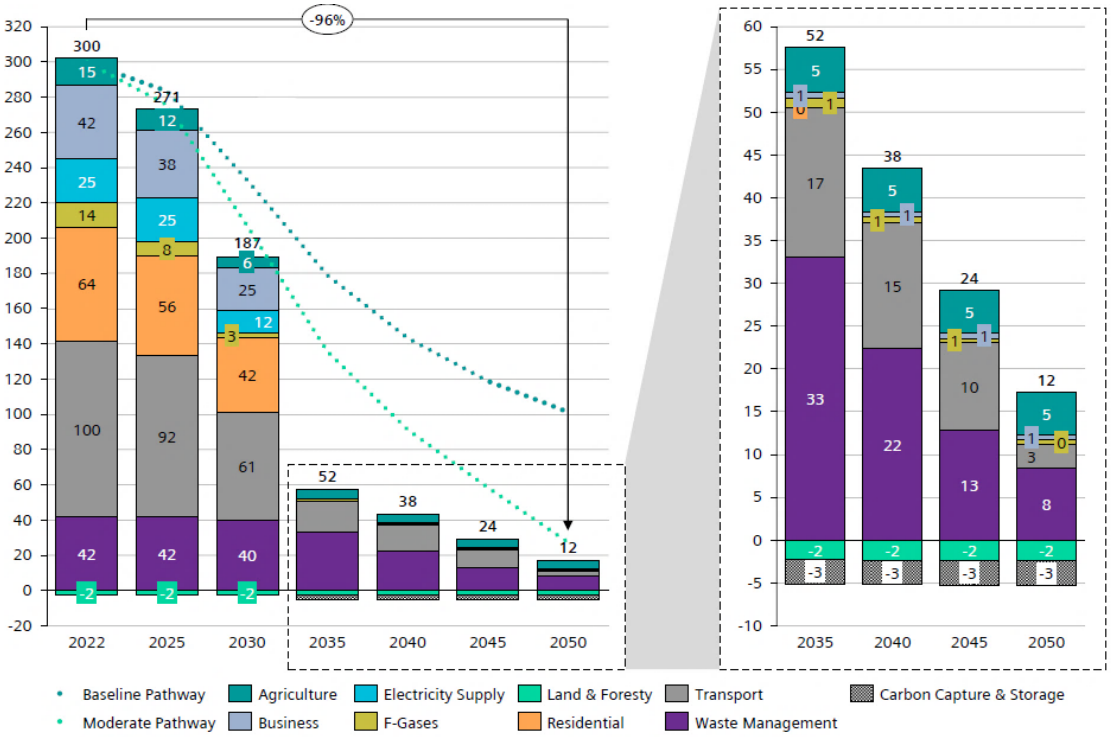

FIGURE 8: AMBITIOUS PATHWAY - THE SIEMENS REPORT

4.14. The Siemens Report outlines that there are multiple benefits to Guernsey of decarbonisation. These include:

- Reduced energy spend and increased resilience;
- Improved economic output;
- Improved health and wellbeing;
- Improved resilience.

4.15. In delivering the baseline, Guernsey could reduce its whole-Island energy spend by up to £67m each year compared with a continuation of the status quo. This rises to up to £99m a year with the moderate pathway and up to £125m a year in the ambitious pathway. By relying less on fossil fuels and producing its own renewable fuels, together with full implementation of the electricity strategy, Guernsey can enhance its energy security and reduce vulnerability to price fluctuations or supply disruptions.

4.16. Transitioning to renewable energy sources and sustainable practices can create new economic opportunities in Guernsey. This can be achieved by investing in green technologies that create new jobs, encouraging businesses to develop their environmental action plans and report their performance, and attracting environmentally conscious businesses to locate in Guernsey.

4.17. Increased levels of sustainable travel and cleaner air resulting from reduced emissions can lead to improved public health, with fewer pollutants leading to lower rates of respiratory conditions and increased activity levels (enabled through active and public transport modes) leading to reduced risk across a wide range of other health issues.

4.18. Implementing net zero initiatives can simultaneously prepare Guernsey for potential climate impacts and ensure that Guernsey is more resilient to extreme weather events, rising sea levels, and other consequences of global warming. Examples of this include improving land management practices to reduce soil erosion and help prevent flooding and improving buildings to protect occupants from temperature fluctuations and reduce the associated health risks.

4.19. The Siemens Report also outlines the estimated level of investment necessary for the delivery of the initiatives to deliver the results, including the longer-term financial savings, noting that the costs would be met by four groups. The States of Guernsey will need to provide publicly shared infrastructure and financial incentives or assistance to businesses and citizens. However, private investment from new or existing organisations can play a significant role in developing or enabling infrastructure projects, as well as in establishing new businesses that could, for example, produce the alternative fuels and provide the active and shared transport services. Finally, individual businesses and citizens will make their own investments in relation to energy efficiency, electrification and switching to alternate fuels, much of which can be incorporated into and adopted through the normal cycles of operation and replacement.

4.20. As outlined above, there are financial upsides to such investment, with Siemens calculating that for the baseline pathway there was a potential for £2,200m GVA (gross value added) for Guernsey's economy from 2025 to 2050. For the moderate pathway, the estimate rises to £4,130m and for the ambitious £5,990m.

4.21. The Siemens Report recommends that, to achieve net zero emissions, the ambitious pathway is adopted. This would enable immediate and positive action and, in future, review the suitability of emerging technological advancements, such as hydrogen and carbon capture technologies, as well as the availability and suitability of external offsetting measures.

4.22. The Siemens Report also sets out a number of actions that would deliver the moderate and ambitious pathways, divided up into six thematic areas (detailed in Section 5 of the Siemens Report):

- Theme 1: Increase efficiency levels and reduce demand;
- Theme 2: Switch to alternative modes of travel;
- Theme 3: Electrify and use renewable fuels;
- Theme 4: Produce renewable electricity and fuels;
- Theme 5: Enhance the natural environment and capture emissions;
- Theme 6: Engage and incentivise stakeholders.

5. Proposed pathway

5.1. Decarbonisation plans should be dynamic and evolve as uncertainties reduce over time. The Committee's initial approach was to propose the choice between the moderate and ambitious pathways. This was aligned with scientific consensus that it will be more difficult for jurisdictions to reduce emissions at a later stage, and that early action is best to be able to meet the 2050 deadline to reach net zero. However, through the development of the pathway work it became clear that further technological advances will be required for the island to reach net zero (although the advanced pathway brings us close). These developing solutions are not yet available at a commercial and affordable level to enable us yet to commit to adopting them.

5.2. Therefore, the Committee proposes an approach that is based upon a series of shorter and more manageable timeframes, with ongoing reviews that will allow Guernsey to continuously adopt and adapt options and technologies as they develop and increase the levels of ambition (in line with the Paris Agreement) accordingly.

5.3. The Committee propose that a seven-year cycle be adopted, with the first seven years, 2025-2032, being focussed on the effective delivery and optimisation of initiatives that are already identified in States-approved strategies and policies. This would require the Committee *for the* Environment & Infrastructure to report back to the States with a review of, and update to, the Pathway to Net Zero not later that the end of 2032.

5.4. The Pathway to Net Zero touches upon almost every aspect of island life, either directly or indirectly, including the built environment, energy, land use, waste, and public health. Adopting new and accelerating existing decarbonisation initiatives can provide many benefits. As outlined within the Siemens Report, these include:

- Reductions in energy expenditure (improved affordability);
- Economic benefits;
- Health improvements;
- Environmental benefits;
- Climate resilience.

5.5. The baseline pathway illustrates that the island is on target to achieve the 2030 target. This is very positive and shows that actions that are already underway are having a positive impact. That the island is on target to achieve the initial target has informed the initial approach to reaffirm the focus upon existing policies and extant resolutions, and to have an increased focus on monitoring the impact of these initiatives. This does not preclude further initiatives within the seven-year period, but it allows for an informed approach to scaling initiatives, based on their own merits.

5.6. The Committee notes that the climate change, energy, housing, and transport policies are all important for continued implementation, as are a number of Government Workplan Priorities. The Committee will undertake to provide a comprehensive list of resolutions that support the Pathway to Net Zero and outline the goals required for each sector over the next seven years. This is in line with the Siemens Report recommendations.

5.7. The review of Phase 1, to 2032, will include a clear assessment of how the States' polices, and other actions identified in the Siemens Report, have been implemented and the effect of these on the island's greenhouse gas emissions. This will then be used to inform an updated plan that will benefit from technological improvements over the course of Phase 1 and will consider further interim targets for of the following period.

5.8. Decarbonisation plans also need to consider the wider impact on society, often referred to as the principles of a just transition – which centre the interests of those that are most affected by the low-carbon transition, including workers, vulnerable communities, suppliers of goods and services (specifically small and medium-sized enterprises – SMEs), and consumers[24] (see Figure 9) – are part of the Paris Agreement. A fair transition should not cost workers or community residents their health, environment, jobs, or economic assets. This principle has been embedded into the development of the Siemens Report.

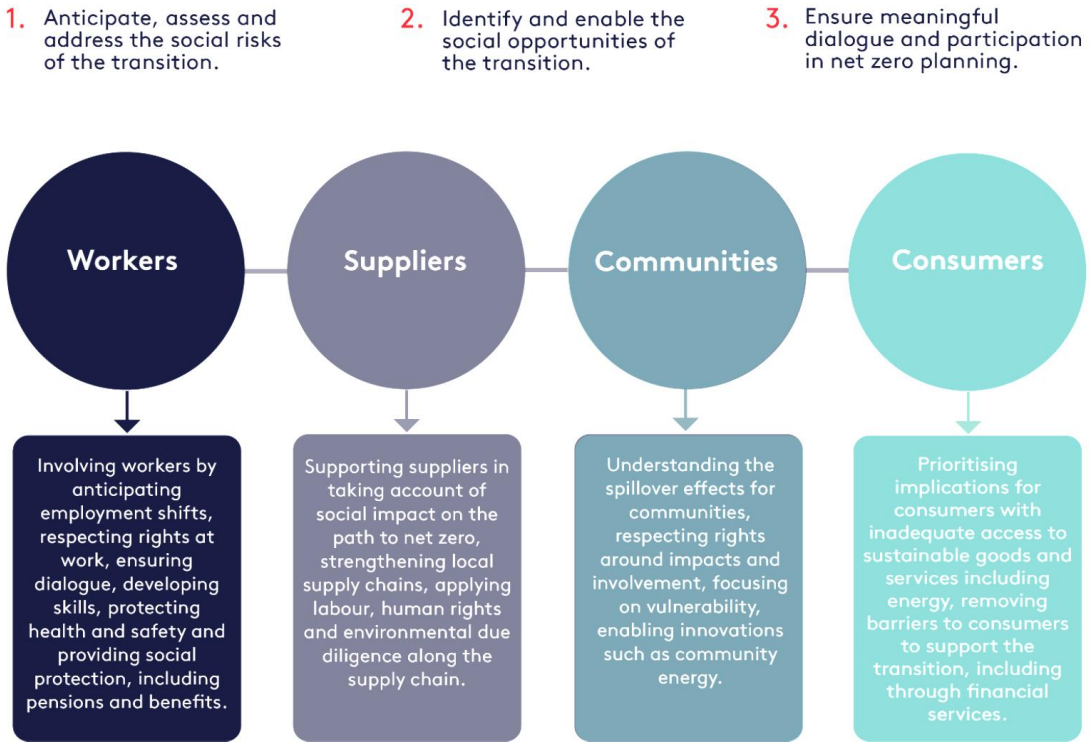

FIGURE 9: PRINCIPAL GROUPS AFFECTED BY THE NET ZERO TRANSITION AND HOW THEY CAN BE INVOLVED AND SUPPORTED THROUGH ACTION TO SECURE A JUST TRANSITION[25]

Key areas of focus

5.9. The Committee outline the following areas for particular attention over the next seven-year period, with initiatives focussing on:

- Energy efficiency of buildings;

[24] https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-just-transition-and-what-does-it-mean-for-climate-action/
[25] https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2022/10/Making-Transition-Plans-Just-2.pdf

- The Electricity Strategy;
- The Integrated Transport Strategy;
- Decarbonisation of heat;
- A Net Zero Forum;
- The States of Guernsey leading by example;
- The natural environment.

Energy Efficiency of Buildings

5.10. Around a fifth of Guernsey's GHG emissions derive from our residential buildings, which rises to around a third with business emissions – essentially how we heat, cool, and run all the equipment in our homes, workplaces, shops and indoor social spaces. Improving the energy efficiency of buildings is already part of the States of Guernsey's energy, housing, and climate policies, and has many benefits including reducing energy costs and improved health and wellbeing outcomes. The implementation also algins with sustainability goals 3, 7, 8, 10, 11 and 13 as outlined in Figure 10.

FIGURE 10: UN - ACTION 2030 - 17 SUSTAINABLE DEVELOPMENT GOALS

5.11. Siemens state, "*There is significant potential to increase the energy performance of existing and new residential buildings in Guernsey. This can be achieved by assessing the energy efficiency level of the existing building stock, introducing minimum energy efficiency standards for rental properties, new builds, and extensions, and introducing an energy certificate scheme to provide visibility to prospective purchasers and tenants, and encourage improvements*."

5.12. Improving energy efficiency goes hand in hand with improving the overall quality of the building stock, whether that is in new builds or through the retrofit of existing buildings, which make up the majority of the potential energy savings and benefits to people.

5.13. Energy efficiency improvements deliver a much wider range of benefits than simply

emissions reduction. More energy efficient homes and workplaces can improve people's living environments, which data shows has a material positive effect on health outcomes. Buildings can be heated or cooled more efficiently, which makes energy bills more affordable and helps to address fuel poverty. The quality of the market can be better understood, and problems can be addressed. This work is intended to catalyse changes that promote more affordable, ethical, healthy, and safe environments, and will be developed with careful consideration to potential market impacts.

5.14. Improved energy efficiency at a macro scale also reduces pressures on the island-wide energy system and helps to protect us from the fluctuations in the energy market, which are becoming more prevalent and can prove expensive. General improvements in energy efficiency would result in a reduction of energy demand and fuel use, saving both a considerable amount of money and emissions at every level, whether that is with respect to the island's power supplies or for individual households.

5.15. Energy efficiency measures encompass a range of improvements including insulation, airtightness, ventilation, solar shading, window and door upgrades, low-energy heating and lighting, and smart controls.

5.16. A key driver for the approach of improving existing buildings is the split between buildings that already exist versus those that will be built in the coming years. Assuming that the projected accommodation requirements set out in the States' Strategic Housing Indicator are met through the creation of additional units, the housing stock in 2050 would be comprised of 76% already built (as of 2023) housing and 24% new build (built between 2024 and 2050). This helps to inform priorities with respect to energy efficiency: while it is obviously important that standards for new build properties are suitable, more focus should be given to already built homes and other buildings, as they will form the significant majority of the buildings in the island in 25 years' time. A retrofit-based approach also reduces the use of virgin material, which is more sustainable and further reduces the carbon emissions associated with construction.

5.17. Energy performance certificates (EPCs) are a means to assess the energy efficiency of buildings, measured and presented in terms of cost and carbon emissions. They (or their equivalents) are a standard tool used in many developed countries, including the UK, Europe, and the USA. Guernsey is the only Crown Dependency that has not yet introduced EPCs. They are detailed enough to be useful, but quick enough to be affordable. They assist both individuals and governments.

5.18. EPCs include costed advice on ways to improve the building's energy efficiency rating and what the potential savings could be. This informs owners, householders and potential purchasers in a way that promotes practical, positive upgrades to save money and improve living conditions. Governments use the data to assess housing stock and inform policy development. EPCs and Building Retrofit can together quantify and address the issue of fuel poverty, improve living standards, mitigate, and adapt to climate change, support commitments to meet net zero carbon, and improve the quality, and fitness for habitation of housing.

5.19. Analysis of the targeted consultation and research undertaken [26] supports the introduction of EPCs, as set out in the Guernsey Housing Plan. However, their introduction should not be limited simply to the housing sector, as the Siemens Report outlines the potential benefits of commercial EPCs.

5.20. Introducing an EPC scheme to Guernsey will have numerous benefits, chiefly related to the acceleration of improved energy efficiency that it will catalyse. There is already demand for EPC assessments from businesses and householders because of the potential cost savings and the access they provide to better rates on some financial products. The information that EPCs generate will help Government to build up a clearer picture of the energy performance of the island's buildings. This can help to inform any minimum building standards to be proposed for new builds, and over time could also help to inform appropriate, achievable standards for existing buildings, taking into account their size, type and age.

5.21. There are broader benefits to the introduction of EPCs, such as upskilling of the workforce around building stock assessments (recommended through the provision of training), and the improvement of data capture, management, and analysis for the States of Guernsey. It will also help to create a deeper knowledge base of energy and carbon efficiency within the island's construction sector.

5.22. The approach to introducing EPCs, which would initially be on a voluntary basis, undergoing consultation, but in summary it will focus on:

- Undertaking the work required to introduce and support EPCs;
- Reviewing building control approach and legislative requirements;
- Continuing engagement with industry;
- Building up information on housing stock;
- Investigating the potential need for grants/incentives;
- Encouraging good quality retrofit;
- The potential eventual introduction of minimum energy efficiency standards.

5.23. The Siemens Report outlines that with the introduction of energy performance assessments, initiatives and minimum standards in the residential sector would result in up to 22% reduction in household emissions from reduced fuel usage leading to a significant reduction in costs long term and improved living conditions leading to health and wellbeing benefits. As an important part of the demand management aspect of the Electricity Strategy, an EPC scheme is estimated in the Siemens Report to reduce islanders' cumulative energy costs by £6 - 14m per annum.

The Electricity Strategy and role of renewable energy

5.24. The Electricity Strategy, as agreed by the States of Guernsey in September 2023, outlined the long-term plan for meeting the island's electricity demand as affordably as possible. The strategy mandates the ongoing exploration of renewable and other

[26] A consultation was undertaken with representatives from the building industry, energy industry and wider business community seeking feedback on whether current approaches were sufficient from an energy efficiency perspective and ways that Government and businesses could support improvements.

technologies to support the system, as well as additional interconnection. Under all scenarios considered in the Siemens Report, the continued implementation of the Electricity Strategy was assumed.

5.25. The Electricity Strategy has actions that relate to various committee mandates, although most are primarily under the Committee *for the* Environment & Infrastructure. The Electricity Strategy Steering Group has therefore been established as a cross-committee body offering oversight of the ongoing implementation of the Electricity Strategy. This body comprises representatives from the Policy & Resources Committee, the Committee *for* Economic Development, the States Trading Supervisory Board and the Committee *for the* Environment and Infrastructure. This approach has enabled a co-ordinated approach to the implementation and ongoing work supporting the Electricity Strategy.

5.26. Through the Electricity Strategy the States agreed near term targets for local renewables – 5% by end of 2025 and 10% by end of 2028 – but did not set targets beyond this date. This is because the intent is to send signal to the market that enable longer term uptake beyond this. The pathway does not seek to propose further targets at this stage, but it will be important to monitor further progress in this area post-2028 to ensure appropriate recommendations can be returned at the next review.

5.27. The Electricity Strategy acknowledges that there may be developments that require adaptation to the implementation of the strategy. This does not mean departing from the overall aims of the strategy but may result in a different overall position to that it outlines. Therefore, the Pathway to Net Zero, whilst assuming the Electricity Strategy will continue to progress, has also assessed opportunities for alternative energy decarbonisation avenues which were not considered during the Electricity Strategy development, the implementation of which may further reduce the overall cost to the island of decarbonisation. This is in line with the Energy Policy which is agnostic to energy type.

Transitioning to Low-Emission Transport

5.28. Transport represents approximately 33% of Guernsey annual GHG emissions[27]. Road transport modes reliant on petrol and diesel combustion are a significant GHG emission contributor. Electrification of road transport – a transition driven primarily by wider market forces – will reduce Scope 1 carbon emissions and significantly improve urban air quality by burning fewer fossil fuels.

5.29. The On-Island Integrated Transport Strategy ("ITS")[28] was approved by the States of Deliberation in 2014. The Strategy is designed to encourage greater uptake of public and non-motorised modes in order to improve efficiency, safety and affordability and reduce congestion and pollution on our road network.

[27] As per Guernsey Greenhouse Gas Emissions for 2022 (https://www.gov.gg/CHttpHandler.ashx?id=176400&p=0)
[28] https://www.gov.gg/CHttpHandler.ashx?id=122811&p=0

5.30. The First Periodic Review [29] of the On-Island Integrated Transport Strategy was published on Friday 27th December 2019, and sets out the progress made against the objectives. Despite some key levers having been removed from the ITS ahead of its implementation, it is meeting its objectives.

5.31. There is an extant resolution from the Climate Change Policy to review the ITS with respect to that policy, and in undertaking this review the options presented in the Siemens Report should be considered.

5.32. The Siemens Report also outlines several potential initiatives to support greater uptake of active travel and public transport. Through the review of the ITS there may be opportunities identified to pilot trials of the initiatives that the Siemens Report sets out in more detail as part of the seven-year action plan. Optimisation of current initiatives to increase the uptake of energy-efficient active and public transport will continue to play an important role.

5.33. Low carbon fuels offer an opportunity to decarbonise the transport sector (and indeed the economy more generally) whilst offering other benefits, particularly in relation to public health. The Siemens Report outlines that there is a potential opportunity for on-island production of renewable fuels, which would support the circular economy. However, the Committee is of the view that market forces will drive this initiative, but the States of Guernsey has an important role supporting industry adaptation. This work should consider the overall economic impact of decarbonised fuels in the heating and transport (and heating – see below) sectors and any potential benefits to the downward pressure on the electricity sector this could provide. This approach is aligned to the Energy Policy and should use the definitions of "low carbon" and "low emission" as outlined in the Electricity Strategy. More broadly the States of Guernsey should seek to be supportive of approaches for the development of alternative fuels where possible.

5.34. The Siemens Report also considered the approaches to be taken for sea and air travel. For air travel the Siemens Report suggest alignment with the UK's Jet Zero Strategy[30]. As the majority of the off-island air travel is to the UK, this is a rational direction; however, given the maturity of the technology is low and the complexity to implement is high (as outlined in the Siemens Report) continued monitoring of the industry with an ongoing review to change is recommended. The transition for maritime vessels is currently less clear and so a watching brief on developments will be pursued.

Decarbonisation of Heat

5.35. The Electricity Strategy sets out the rationale for a strategy for decarbonising heat (initiative 5.1.3.A) and this is impacted by both energy efficiency and the availability of low carbon energy sources. As with transport, low carbon fuels offer an opportunity to decarbonise the economy whilst offering other benefits, in particular in ration to public health.

[29] https://www.gov.gg/CHttpHandler.ashx?id=122741&p=0
[30] https://assets.publishing.service.gov.uk/media/62e931d48fa8f5033896888a/jet-zero-strategy.pdf

5.36. The main contributor to GHG emissions from residential buildings are their heating systems. Currently, around 65% of houses use fossil fuel combustion heating, powered with gas oil, kerosene, or LPG. The Electricity Strategy has an assumption that 90% of heating systems will be electrified by 2050. However, acknowledging the complexity in this process, some heating systems could be switched to low carbon fuels instead (as explored int the "Transitioning to Low-Emission Transport" section above). This may result in overall economic benefit to the island and should be further investigated.

5.37. Any strategy for the decarbonisation of heat should include energy efficiency measures alongside alternative solutions and consider the approach to any subsidies. Any initiatives that require additional funding would be subject to future funding request(s) from the States.

Establishment of a Local Net Zero Forum

5.38. From stakeholder engagement through the development of the pathway work, there is evidence that a States of Guernsey-facilitated forum that covers areas of climate action, net zero pathway plans and pledges for local businesses and organisation could be beneficial. The States of Guernsey would use the forum to continue to work collaboratively with stakeholders who share interest in local action to support climate action and meeting net zero targets and continue to share insights and work with the initiatives and actions provided by the Siemens Report. The forum would continue to facilitate collaborative action and stimulate demand for solutions across all emissions sectors and work to bring about near-term co-benefits for islanders and who are connected globally and share climate goals.

5.39. The net zero forum can also be used to help the States of Guernsey to develop its own operational GHG emissions inventory. The project would be transparent, collaborative, and educational and share good (and poor) practices, as well as creating a means to drive uptake and adoption of solutions for increased active travel and buildings energy efficiency.

5.40. The forum will also cover action on the broader Climate Change Policy 2020-2050 setting. There is interest and expertise in climate action and sustainability fields on-island, as well as high levels of interest and commitment to safeguard the island's natural environment with increased climate action. The forum can also support the development of sector specific strategies, in line with the Siemens Report recommendations. Net zero is a challenge for everybody to play their part, working collaboratively and systemically can help bridge the gap between what Guernsey can achieve and should achieve.

5.41. The Energy Partnership has been a helpful vehicle for local energy organisations to connect with the States of Guernsey and to support policy development[31]. It has been an ongoing success. A great deal of engagement can be achieved within existing

[31] The Energy Partnership was established in 2020, and has developed the Energy Policy 2020 – 2050, the Climate Change Policy 2020 – 2050, the Electricity Strategy 2023, and the Decarbonisation Options for Guernsey Siemens Report, without increasing existing energy and climate change government budgets.

budget and with limited resource in this way.

5.42. Given the broad spectrum of subject areas that are covered, it will be important that the relevant States of Guernsey staff are involved at the right times. A systemic approach that builds on our relationships and connections with government and organisations working collaboratively and in partnership will be the most effective and cost-effective method.

5.43. Possible areas and themes for the Net Zero Forum to explore include and are not limited to:

• Working with local climate action and sustainability organisations to collaboratively develop an approach for local businesses to adopt and achieve net zero targets, the initial focus could be on buildings and on-island travel/transport emissions.
• The potential for a ratings scheme or authentication model for local businesses and organisations that commit to net zero can be awarded and credited for their positive impact to use in their marketing material. This can be explored with what is readily available locally and could be developed further.
• Engagement with local organisations to drive demand for initiatives and pilot schemes to reduce on-island emissions as well as exploring ways to evidence impact and uptake.
• Support and develop the implementation of buildings energy efficiency initiatives.
• The development and undertaking of a States of Guernsey organisational emissions assessment and decarbonisation plan, working collaboratively for the mutual benefit of other organisations.

FIGURE 11: THEMES FOR A NET ZERO FORUM

The States of Guernsey Leading by Example

5.44. The States of Guernsey leading by example with its own credible, robust, and transparent emissions reporting and decarbonisation plan for its operations is an important part of a robust pathway to net zero. The Committee is proposing that a comprehensive assessment of the States' own operations be undertaken. This will lead to a decarbonisation plan to reduce the organisation's environmental impact, improve its efficiency, and reduce its costs.

5.45. A decarbonisation plan is a series of actions to be implemented according to a specific GHG reduction target to reduce carbon emissions. The plan should be achievable and backed by science, and it also needs to be flexible to respond to evolving ideas, technologies, and regulations. A decarbonisation plan should be similar to any other strategy, with robust financial and operational plans and forecasts. The first stage in any decarbonisation plan is establishing a GHG inventory and setting its targets. It can then be established where and how reductions can be made.

5.46. When developing a plan, it can be helpful to consider a hierarchy like the IEMA GHG

Management Hierarchy:

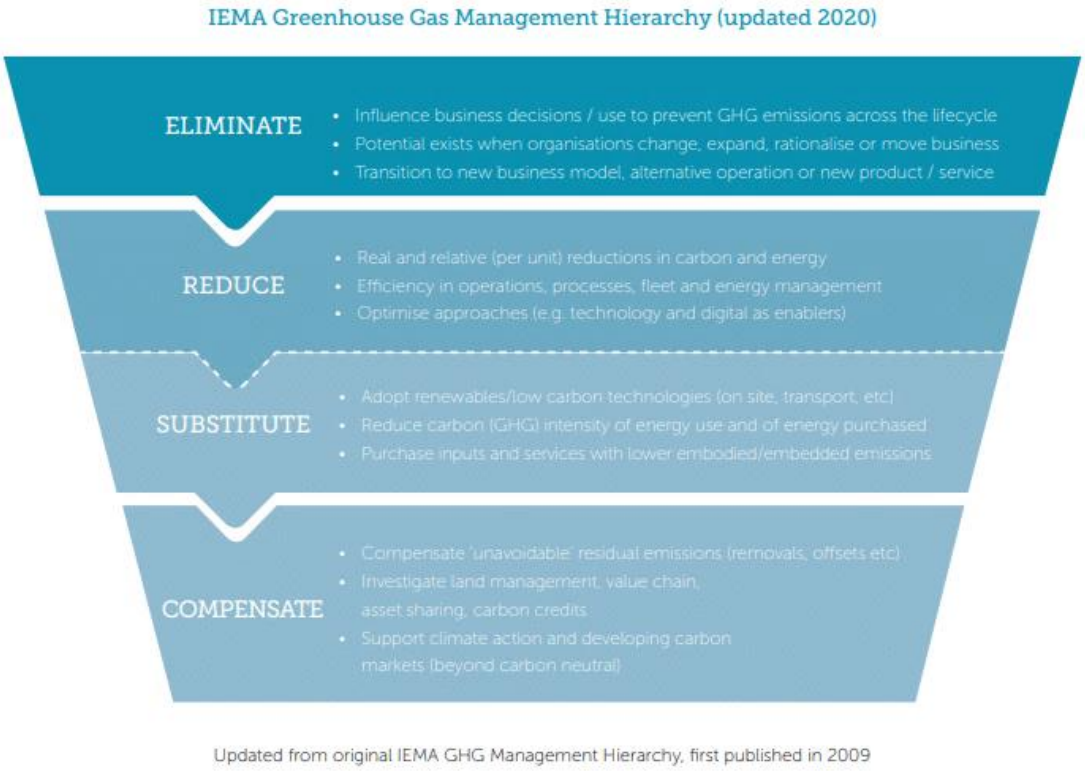

FIGURE 12: GREENHOUSE GAS MANAGEMENT HIERARCHY

5.47. Operational decarbonisation plans can be split into short-term (1-5 years), medium term (5-10 years) and long-term actions (10 years+). The short-term plans should include clear set delivery dates with responsibilities, actions that are fully costed, encourage front loading of emissions reductions, and include existing plans and programmes. Long-term plans may not be fully formed or have accurate costings, but they can start to use carbon removals for residual emissions, if following the Science Based Targets initiative (SBTi[32]) standard or similar.

5.48. The States of Guernsey GHG emissions inventory and subsequent decarbonisation plan can be used on island as a case study. It will lead to more collaborative sharing of best practice for organisations and local businesses through the Net Zero Forum, as well as driving demand for solutions that be fulfilled locally.

5.49. It is increasingly considered best practice for organisations to disclose their carbon emissions annually, alongside plans for emissions reduction, as part of their annual public reporting. Disclosure ensures support from stakeholders and monitors progress on the journey to net zero. It also interests investors as it identifies what has been achieved and how the organisation compares against peers. The States of Guernsey can demonstrate best practice and lead by example, to motivate more organisations to play their part.

5.50. As part of the States leading by example, opportunities for trials within the States

[32] https://sciencebasedtargets.org/

operations should be explored. The Committee will continue to liaise with and support the energy sector in the development, and implementation, of their own decarbonisations plans and report back in due course with any recommendations on support and ongoing progress of the energy sector.

The Natural Environment

5.51. Guernsey's natural environment offers the opportunity to sequester carbon from the atmosphere, reducing the island's overall impact. The inventory complied by Aether illustrates that the island's land use currently sequesters around 2ktCO_2e annually. This is supported by existing island policies and strategies, such as the Strategy for Nature, and the requirements for net gain as part of developments under Planning policy.

5.52. The Siemens Report assessed that there is unlikely to be much scope to increase this based on current planned development. However, that does not mean there are no opportunities to do so, with improvements in farming practices in particular offering further land use potential, and opportunities potentially to be identified through the Marine Spatial Plan. It is therefore important that the implementation of these policies and plans is continued.

5.53. The Siemens Report also outlined that there is potentially limited potential for sequestration in the marine environment, however this is based on limited information in Guernsey's marine environment. Therefore, the work developing the Marine Spatial Plan, a Government Work Plan priority, will be vital in assessing potential economic and carbon positive opportunities. The blue carbon assessment, as part of the Marine Spatial Plan, will provide the basis for exploring these opportunities.

6. Extant Resolutions

6.1. The Committee has identified that if the States approve the Pathway to Net Zero with a seven-year review period, the following extant resolution will be superseded and therefore, the Committee proposes, should be rescinded, as follows:

Extant States' Resolution for Rescission	
Resolution Date	18th August 2020
Billet and Article	Billet d'État XVI of 2020, Article VIII
Original Sponsor	The Committee *for the* Environment & Infrastructure
Title	Mitigate Climate Change - States of Guernsey Climate Change Policy & Action Plan
Resolution	4) To direct the Committee for the Environment and Infrastructure to bring a review and update of the Climate Change Action Plan to the States at least once every 2 years, as set out in paragraph 10.1 of the policy letter.

Update	Through the agreement of the approach set out within this policy letter, this resolution will become superseded by the direction agreed. This policy letter proposes a seven-yearly review cycle approach for the Pathway to Net Zero, which effectively replaces the Climate Change Action Plan

FIGURE 10: EXTANT RESOLUTIONS FOR RESCISSION

7. Funding

7.1. There is no additional funding requested as a result of this policy letter.

7.2. The Committee is conscious of the financial situation facing the States of Guernsey. The Pathway to Net Zero is a Government Work Plan Priority and has set out the opportunities and difficulties in reaching net zero by 2050. The Committee has taken a pragmatic approach to the recommended plan for the States of Guernsey to adopt and, noting that the Siemens Report does not offer a net zero solution using currently mature technology, has therefore proposed a seven-year review period. The first seven years are focussed upon existing States of Guernsey policies and strategies and the implementation of these such that align to the decarbonisation of the island.

7.3. As the pathway focusses on the importance of ongoing initiatives, and supporting local industry, the initial work can be met through currently approved resources and budgets. Much of the proposed work involves further research and monitoring. Any initiative that requires additional funding or legislation will be returned as a proposal to the States for the Assembly's consideration on its own merits.

8. Compliance with Rule 4

8.1. Rule 4 of the Rules of Procedure of the States of Deliberation and their Committees sets out the information which must be included in, or appended to, motions laid before the States.

8.2. In accordance with Rule 4(1):

a) The Committee for the Environment & Infrastructure confirms that the recommended strategic direction is in line with the priorities set out in the Government Work Plan, specifically relating to Free Trade Agreements & Related International Obligations as part of the ongoing implementation of the Paris Agreement.

b) In preparing the propositions, consultation has been undertaken with external stakeholders and operational staff as part of and following the development of Appendix 1. Consultation with the Development and Planning Authority is underway relating to the implementation of the energy efficiency of buildings workstream

c) The propositions have been submitted to His Majesty's Procureur for advice on any legal or constitutional implications.

d) The financial implications to the States of carrying the proposal into effect are as outlined in Section 7 of this policy letter.

8.3. In accordance with Rule 4(2):

a) The propositions relate to the Committee's policy responsibilities relating to climate change.

b) The propositions have the unanimous support of the Committee.

Yours faithfully

H L de Sausmarez
President

A Gabriel
Vice-President

A Cameron
S Fairclough
A D S Matthews

SIEMENS

States of Guernsey

PROJECT REFERENCE: 76-1328

Decarbonisation Pathway Options for the Island of Guernsey

Final Report: Version 1.02

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Document Log

Version	Name	Author	Date
V0.1	Draft Report	Siemens PTI & Aether	05/07/2024
V1.0	Final Report	Siemens PTI & Aether	30/08/2024
V1.01	Final Report with minor clarifications	Siemens PTI & Aether	25/09/2024
V1.02	Final Report with Waste sector clarifications	Siemens PTI & Aether	08/10/2024

Abbreviations

£k	Thousands of pounds
£m	Millions of pounds
AD	Anaerobic Digestion
BGWwC	Belle Greve Wastewater Centre
CapEx	Capital Expenditure
CCC	Climate Change Committee
CCS	Carbon Capture and Storage
CER	United Nations Certified Emission Reductions
CHP	Combined Heat and Power
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	CO_2 equivalent
DPI	Dry Powder Inhaler
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Programme
EPC	Energy Performance Certificate
eHeating	Electric Heating
ERF	Energy Recovery Facility
EU	European Union
EV	Electric Vehicle
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GF1	Guernsey-France interconnector
GHG	Greenhouse Gas
GJ	Giga Joules
GJ1	Guernsey-Jersey interconnector
GVA	Gross Value Added
GWP	Global Warming Potential
H2	Hydrogen
H_2S	Hydrogen Sulphide
HDPE	High-density polyethylene
HFC	Hydrofluorocarbon
HFO	Heavy Fuel Oil
HGV	Heavy Goods Vehicle
HVAC	Heating, Ventilation, Air and Cooling systems
ICE	Internal Combustion Engine
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
km	Kilometres
$ktCO_2e$	Kilotonnes of CO_2 equivalent
$ktCO_2e$/year	Kilotonnes of CO_2 equivalent per year
kW	Kilowatt
kWh	Kilowatt hours
LFG	Landfill Gas
LGV	Light Goods Vehicle
LPG	Liquified Petroleum Gas
LULUCF	Land Use, Land Use Change and Forestry
Mth	Megatherm
MW	Megawatt
MWh	Megawatt hours
N_2O	Nitrous Oxide
N_2CH_4	Ammonium Cyanide
ORC	Organic Rankine Cycle
PV	Photovoltaics
RDF	Refuse Derived Fuel
SAF	Sustainable Aviation Fuel
SDG	Sustainable Development Goal
SRF	Solid Recovered Fuels
TOL	Take-off and Landing
tpa	tonnes per annum
UN	United Nations
VER	Gold Standard Voluntary Emission Reductions
VCS	Verified Carbon Standard
WRATE	Waste and Resources Assessment Tool for the Environment

Glossary

Anaerobic Digestion: A chemical process in which microorganisms break down organic matter without the presence of oxygen. During this process, biodegradable materials are broken down into carbon dioxide (CO_2) and methane (CH_4) gas.

BioLPG: A liquefied fuel that arises from the processing of Refuse Derived Fuel (RDF) by gasification technology, which produces a fuel that is chemically identical to conventional Liquefied Petroleum Gas (LPG), and can be used in an air-based gas grid system.

Biomethane: A gaseous fuel that arises from a refined (CO_2 reduced) biogas, achieved from anaerobic digestion of organic matter such as food waste, manure, animal rendering and sewage, and can be liquefied to be used as a transport fuel in road vehicles and/or marine vessels.

CO_2 equivalent (CO_2e): Covers all greenhouse gas emissions that contribute to climate change, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and refrigerant gases like hydrofluorocarbons (HFCs), considering the Global Warming Potential of the gases.

Decarbonisation Pathway: The emission factors and interventions modelled during the period 2022 to 2050, to meet the States of Guernsey's objectives, notably stated in the Energy Policy 2020-2050 and Climate Change Policy.

Energy Recovery Facility: A waste management facility where Refuse Derived Fuel, which cannot be recycled, is safely incinerated to recover electricity.

Gasifier: A waste-to-energy facility that uses a gasification process to produce useful bioenergy and other industrial products from Refuse Derived Fuel and biomass. In this process, carbon-containing materials are converted into synthetic gas and further processed by CO_2 stripping into outputs such as useable BioLPG.

Gas Oil: Liquid fuel used in industrial engines (a tax rebated version for allowable applications is known as 'red diesel' in the UK).

Global Warming Potential: The impact a greenhouse gas will have on atmospheric warming over a period of time, relative to carbon dioxide (CO_2).

Greenhouse Gas Inventory: A dataset which presents estimates of different greenhouse gases from a wide range of activities in a defined geographical area over a period of time.

Net Zero: Emitting no Greenhouse Gas Emissions (GHG) and/or offsetting emissions through actions achieved such as tree planting or employing technologies that can capture carbon before it is released into the air.

Scope 1 Emissions: Direct emissions arising from Guernsey's activities, including emissions that come from burning fuels to heat buildings and driving vehicles with internal combustion engines.

Scope 2 Emissions: Emissions arising from imported electricity.

Scope 3 Emissions: Emissions associated with Guernsey's consumption of goods and services, including energy used to manufacture and transport goods to Guernsey, and fuels used in maritime and aviation transport that is not between Guernsey and the UK or other Crown Dependencies. Scope 3 emissions are excluded from the study and report.

DECARBONISATION PATHWAY OPTIONS FOR THE ISLAND OF GUERNSEY

1.0 Executive Summary

The States of Guernsey's Climate Change Policy[1] sets a target for Guernsey to achieve net zero emissions by 2050, with a 57% reduction in emissions by 2030 compared to the levels recorded in 1990. The Committee *for the* Environment & Infrastructure commissioned this document to identify options for achieving net zero emissions in line with the agreed targets and additionally for an increased level of ambition – achieving net zero emissions by 2040 and reducing emissions by 68% (by 2030) and 78% (by 2035) compared to the levels recorded in 1990.

The aim of this document is to set out **decarbonisation pathway options up to 2050** to enable the delivery of Guernsey achieving its targets in its Climate Change Policy, and its commitments to the Paris Agreement[2]. A **Baseline pathway** projects Guernsey's Scope 1 and 2 GHG emissions up to 2050 for road, maritime and aviation modes of transport, residential and business uses of energy, the supply of electricity, treatment of waste, use of F-gases, and land use sectors. **Moderate and Ambitious pathway options** apply measures to the sectors, with an aim of working towards net zero. Proportionate interventions are proposed to achieve the pathways, together with indicative implementation costs and benefits, and Guernsey's impact on emissions outside of its jurisdiction are estimated for visiting cruise ships and exported waste. The developed pathways are presented in the same way as Guernsey's reported GHG emissions between 1990 and 2022.

Achieving Net Zero Emissions and Summary of Benefits

Decarbonisation is a collective endeavour that necessitates all jurisdictions and individuals to reduce their consumption and waste, invest in energy efficiency and electrification, and switch to using renewable fuels. Only united action can bring about the necessary change to curb the severe effects of climate change.

Achieving net zero emissions will be challenging to achieve in Guernsey, and globally. The developed decarbonisation pathway options in this document progress a long way to achieving net zero in Guernsey, however a residual level of emissions remain that will still need to be abated. The International Energy Agency expects that almost half of the reductions in global emissions in 2050 will need to come from technologies that are currently at the demonstration or prototype phase[3]. All jurisdictions, including Guernsey, will therefore depend on major innovation efforts and substantial technology development to support their net zero roadmaps up to 2050. A high level of ambition will therefore be required and the gap to achieving net zero in Guernsey will need to be solved. Guernsey's spatial constraint makes it particularly challenging to increase the level of emissions that can be absorbed in the natural environment, and will therefore require greater emphasis on reducing emissions in the global race to achieve net zero.

Interventions within the developed pathways, comprised of carbon reduction and carbon capture measures, and circular economy opportunities that will additionally enhance fuel security, will enable Guernsey to facilitate a continued decarbonisation journey. The interventions are grouped into six (6) decarbonisation themes, and summarised in Table 1.

[1] Committee *for the* Environment & Infrastructure – Climate Change Policy & Action Plan [P.2020/127]
[2] The Paris Agreement | UNFCCC
[3] IEA, Net Zero by 2050

Table 1: Sector coupling themes for decarbonisation

Decarbonisation Theme	Summary of Interventions
Increase efficiency levels and reduce demand	Improve fabric and efficiency of existing and new buildings, replace refrigerants, update aircraft and sea vessel fleets, and improve dairy yields
Switch to alternative modes of travel	Introduce bike and car sharing schemes at scale to reduce car ownership and traffic levels, and substitute short-distance flights with high-speed electric water taxis
Electrify and use renewable fuels	Switch to using electric vehicles, vessels and heating, and use only renewable fuels
Produce renewable electricity and fuels	Implement the electricity strategy to enable electrification, and utilise local waste and wastewater to locally produce sustainable fuels for heating and transport
Utilise and enhance the natural environment	Adopt sustainable agricultural practices, improve wastewater treatment, and use land and sea to naturally capture and embed emissions
Engage and incentivise stakeholders	Need for communication and education to achieve buy-in from citizens and businesses, and financial incentives and disincentives to encourage action and positive change

In addition to the primary aim of reducing emissions and achieving net zero, the successful implementation and adoption of an Ambitious pathway, and associated interventions, offers the following notable benefits to Guernsey:

- Transitioning to a low carbon economy can **create jobs, stimulate innovation and reduce economic risks** associated with the effects of climate change. For example, the energy sector will produce renewable fuels and supply solutions that enable electrification, the construction sector will introduce energy efficiency measures into existing as well as new buildings, and the financial services sector might lend and/or fund the investment that will be required.
- Locally producing bio-fuels could **introduce a level of energy security**, achieved by meeting up to 39% of residential and business gas needs and up to 97% of road and maritime transport fuel needs, and could **mitigate against the risk of higher future costs** associated with exporting and incinerating waste.
- Reducing the use of conventional fuels and motorised transport and improving land management practices and sewage treatment will **improve the environment and lead to better public health**, which would result from improved air and water quality, together with increased levels of active travel.

A comparison of the Baseline, Moderate and Ambitious pathways is summarised in turn below, and described in more detail in sections 3.0 and 4.0 of this report.

Baseline Pathway

Between 1990 and 2022, Guernsey reduced its emissions by 46.8% from 561 $ktCO_2e$ to 300 $ktCO_2e$. This level of reduction was largely achieved by switching to imported electricity supply, reducing the use of fossil-fuels by residences, businesses (including industrial processes) and road transport vehicles, and reducing the use of waste landfill.

In 2022, Guernsey's 300 $ktCO_2e$ of emissions (after 2 $ktCO_2e$ of offset emissions due to the presence of woodland and grassland) were comprised of Transport (33%), Residential (21%), Business – including industrial processes (14%), Waste Management (14%), Electricity Supply (8%) and Agriculture (5%) sectors, and F-gases contributed 5% of emissions.

Up to 2050, it is estimated that Guernsey's emissions will decrease to 101 $ktCO_2e$, representing a 66% reduction compared to 2022 levels. This significant reduction, which allows for an increase in emissions because of the effects of economic and population growth, can be largely achieved by the adoption of electric vehicles and heating, declining historical landfill emissions, and implementing the electricity strategy.

As a result of agreed policy decisions listed above, Guernsey's remaining 101 $ktCO_2e$ of emissions in 2050 would become comprised of Aviation & Maritime (38 $ktCO_2e$), Business – including industrial processes (28 $ktCO_2e$), Agriculture (13 $ktCO_2e$), Residential (11 $ktCO_2e$), Waste Management (8 $ktCO_2e$), F-gases (4 $ktCO_2e$), and Electricity Supply (2 $ktCO_2e$), and with offset emissions from natural sequestration (-2 $ktCO_2e$). Projected emissions for the Baseline pathway up to 2050 are shown in Figure 1, together with the actual levels reported in 1990 and 2022.

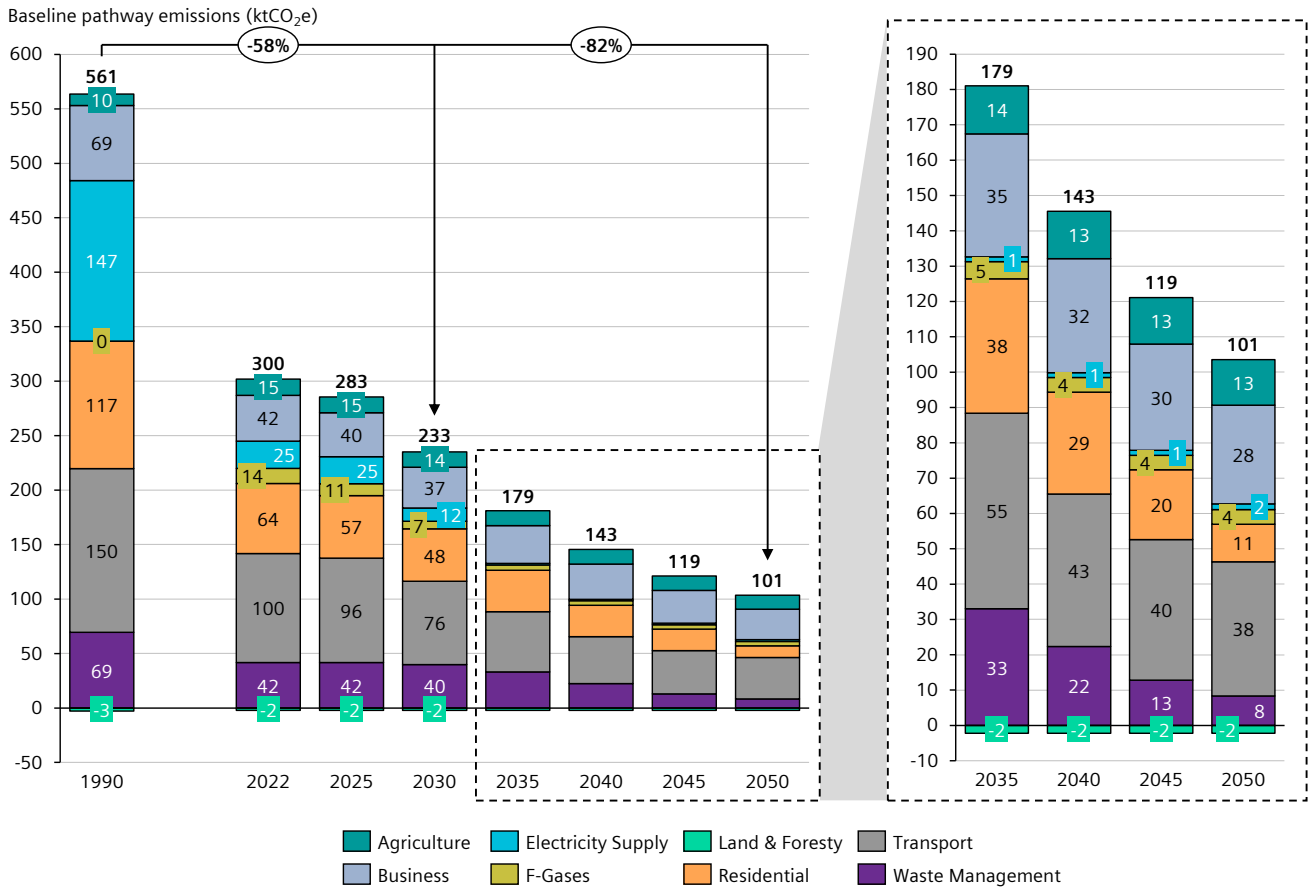


Figure 1: Baseline pathway

In relation to the States of Guernsey's Climate Change Policy, the Baseline pathway suggests that Guernsey is on target to achieve its interim target of reducing emissions by 57% compared to the levels recorded in 1990. However, achieving net zero emissions by 2050 would not occur, with 101 ktCO2e remaining.

The States of Guernsey recognises that its policy of exporting waste and welcoming visiting cruise ships contributes to emissions that result outside of its jurisdiction and GHG reporting. For exported waste, it is estimated that road and sea transportation contribute approximately 0.9 ktCO2e/year (refer to section 3.10.1 for visual representation and detail) to UK and Scandinavian emissions. Based on 76 visiting cruise ships each year, between 1 and 6 ktCO2e/year of emissions would be determined by the average size, age, and efficiency of a vessel (refer to section 3.10.2 for basis of calculation).

Moderate Pathway

The implementation and adoption of proposed carbon reduction interventions in the Moderate pathway could reduce Guernsey's net emissions to 27 ktCO2e by 2050, representing a 91% reduction compared to 2022 levels. This reduction can be achieved by implementing energy efficiency measures into existing residential and business buildings, encouraging electric marine vessel adoption and switching existing vessels to using renewable fuels, making available alternative modes of travel and transportation supported by financial incentives and disincentives, encouraging new farming practices to increase yields from reduced cattle herds, establishing small-scale fuel production from food and agricultural waste, and importing only renewable fuels from 2050.

As a result of the proposed interventions, Guernsey's remaining 27 ktCO2e of emissions in 2050 would become comprised of Aviation (11 ktCO2e), Agriculture (8 ktCO2e), Waste Management (8 ktCO2e), Electricity Supply (2 ktCO2e), F-gases (1 ktCO2e) and Business (1 ktCO2e), and with total offset emissions from natural sequestration (-2 ktCO2e)[4]. Projected emissions for the Moderate pathway up to 2050 are shown in Figure 2, together with the actual levels reported in 1990 and 2022.

[4] Please note that the emission values are calculated to several decimal places and that the presented sums are based on the non-rounded values

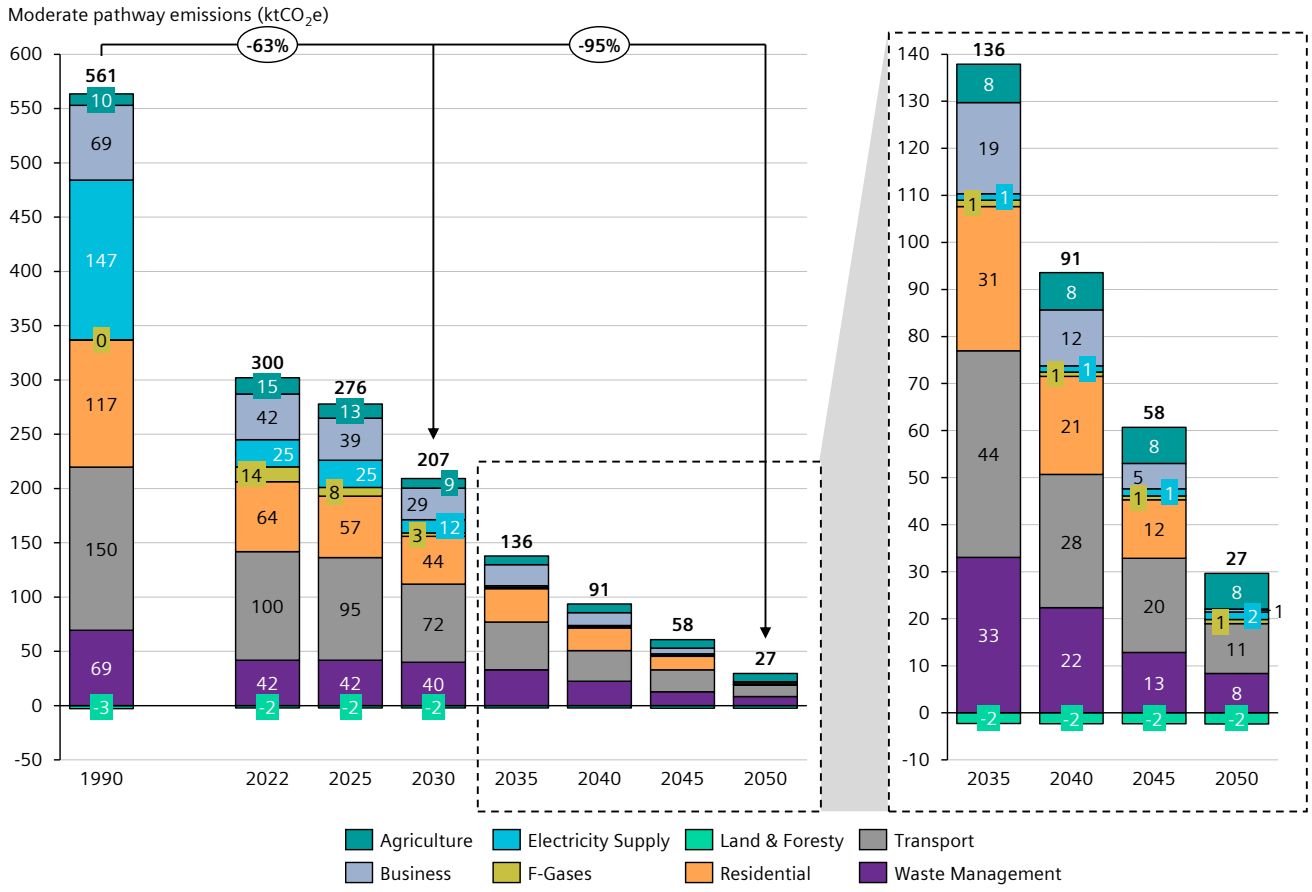


Figure 2: Moderate pathway

In relation to the States of Guernsey's Climate Change Policy, the Moderate pathway suggests that Guernsey could exceed its target of reducing emissions by 57% compared to the levels recorded in 1990. However, achieving net zero emissions by 2050 would still not occur, with 27 ktCO2e remaining.

Ambitious Pathway

The implementation and adoption of proposed carbon reduction interventions in the Ambitious pathway could reduce Guernsey's emissions to 12 ktCO2e by 2050, representing a 96% reduction compared to 2022 levels. This reduction can be achieved by increasing and accelerating levels of energy efficiency and electrification compared to the Moderate pathway, replacing flights with timetabled and frequent electric water taxi service from 2035 for travel between Guernsey and Channel Islands, establishing large-scale fuel production using wastewater and solid waste, importing only renewable fuel from 2035, and increasing the sizing of renewable generation.

As a result of the proposed interventions, Guernsey's remaining 12 ktCO2e of emissions in 2050 would become comprised of Waste Management (8 ktCO2e), Agriculture (5 ktCO2e), Aviation (3 ktCO2e), Business (1 ktCO2e) and F-gases (<1 ktCO2e), and with total offset emissions from natural sequestration (-2 ktCO2e) and carbon capture technologies (-3 ktCO2e)[5]. Projected emissions for the Ambitious pathway up to 2050 are shown in Figure 3, together with the actual levels reported in 1990 and 2022.

[5] Please note that the emission values are calculated to several decimal places and that the presented sums are based on the non-rounded values

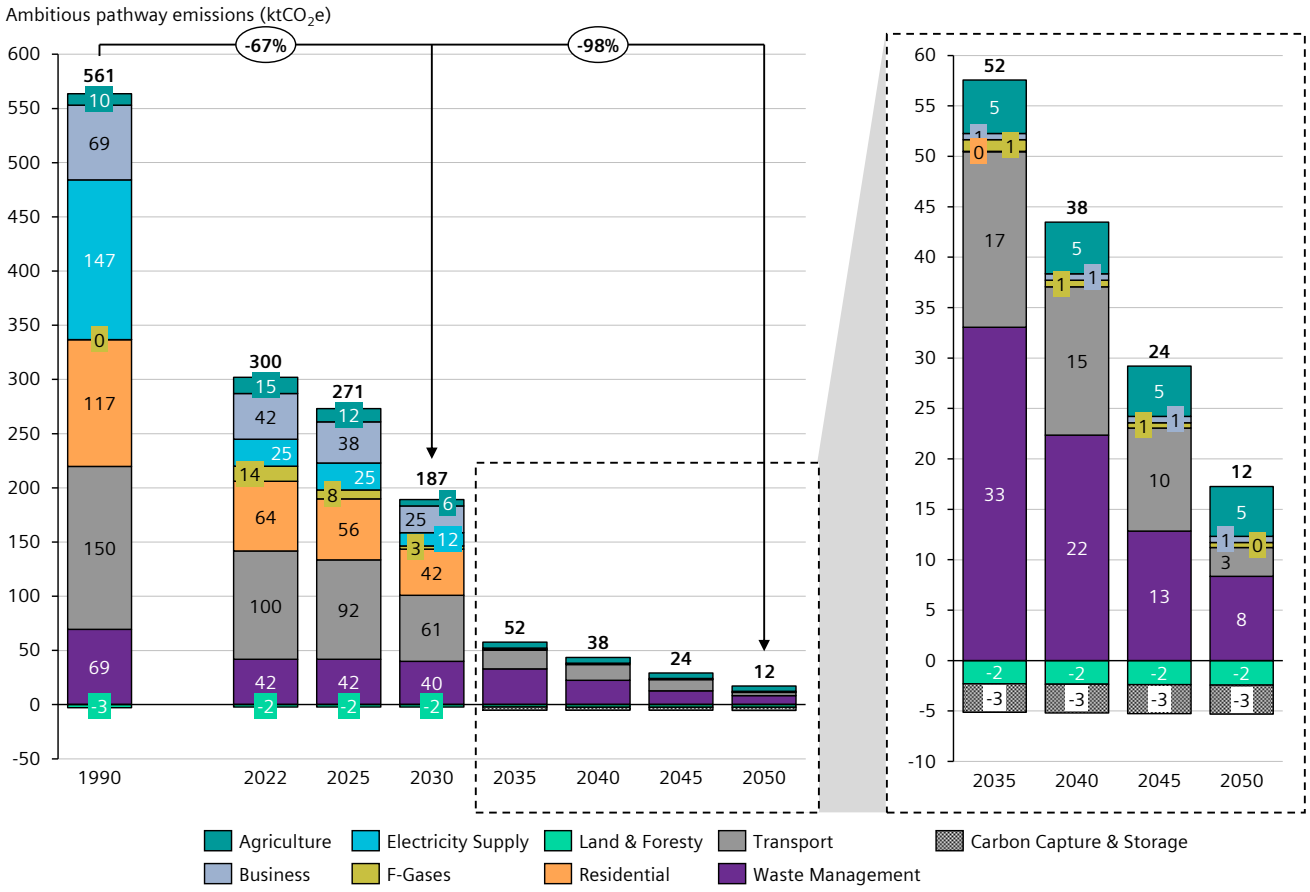


Figure 3: Ambitious pathway

In relation to the States of Guernsey's climate change ambitions, the Ambitious pathway suggests that Guernsey could possibly achieve its ambitions of reducing emissions by 68% by 2030 and 78% by 2035 compared to 1990 levels. However, achieving net zero emissions by 2040 or 2050 would not occur, with 38 ktCO2e and 12 ktCO2e remaining, respectively.

For emissions that currently fall outside of Guernsey's reporting, the implementation of local Anaerobic Digestion and Gasification plants in the Ambitious pathway would prevent approximately 831.3 tCO2e/year of transport-related emissions that occur outside of its jurisdiction and repatriate 7.73 tCO2e/year of landfill emissions.

Cumulative Emissions for the Pathways

For the developed pathways, Figure 4 shows a direct comparison of cumulative emissions and the level of emissions at five-yearly intervals. Compared to the Baseline pathway, which generates 5,469 ktCO2e of emissions up to 2050, enacting the Moderate pathway would reduce cumulative emissions by 21% and enacting the Ambitious pathway would reduce cumulative emissions by 37%.

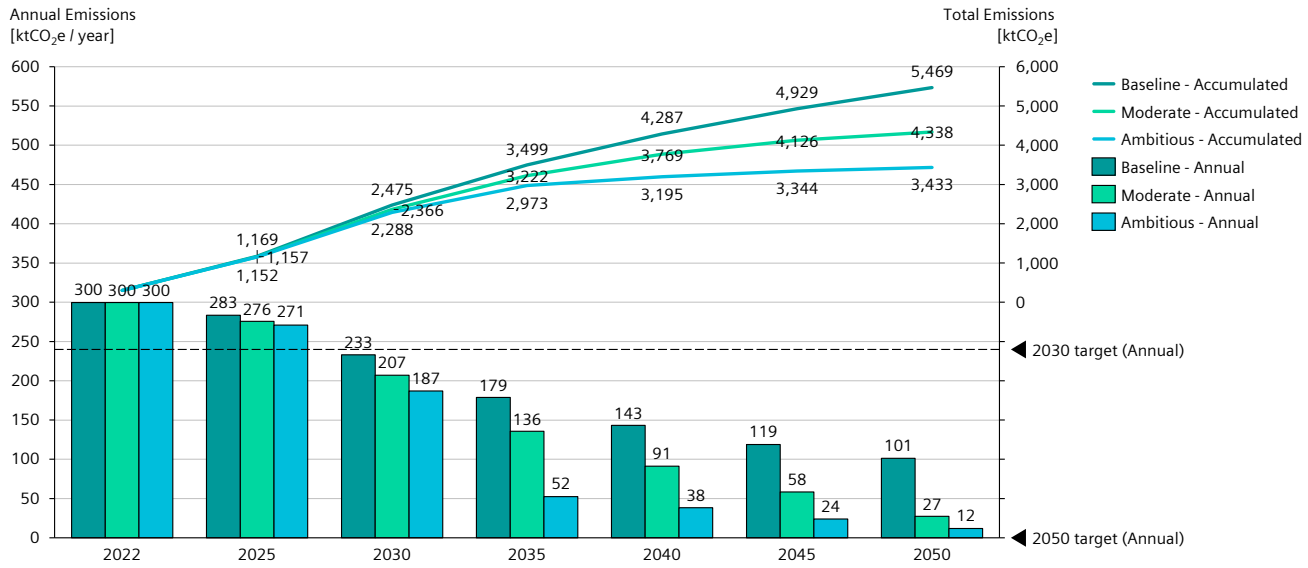


Figure 4: Emissions for Baseline, Moderate and Ambitious pathways (2022 - 2050)

Required Investment for the Pathways and Benefits

The investment required to achieve each pathway includes capital expenditure (based on current monetary value and price levels) for public and private investment in infrastructure and assets, together with financial incentives or assistance that the States of Guernsey might offer to assist citizens and businesses with the implementation of carbon reduction measures. The presented expenditures therefore do include, for example, the cost of replacing heating systems and procuring shared bikes, buses and cars. However, the presented expenditures do not include, for example, costs that citizens and businesses will incur when purchasing electric vehicles or vessels as part of a natural replacement. Table 2 provides a direct comparison of the indicative investment up to 2050 to achieve the Baseline, Moderate and Ambitious pathways, together with the level of emissions that could be abated and an estimation of whole-Island energy cost savings and economic growth. A breakdown of the benefits for each intervention is shown in Table 10.

Table 2: Required investment to achieve the developed pathways with benefits

	Baseline Pathway (with Agreed Policy Decisions)	**Moderate Pathway** (Total)	**Ambitious Pathway** (Total)	**Moderate Pathway** (Additional to Baseline)	**Ambitious Pathway** (Additional to Moderate)
Required Investment up to 2050	£779m	£1,272m	£1,740m	+£493m	+£469m
Cumulative Emissions abated up to 2050	3,231 $ktCO_2e$	4,362 $ktCO_2e$	5,267 $ktCO_2e$	+1,131 $ktCO_2e$	+905 $ktCO_2e$
Energy Savings (per year)	£67m	£99m	£125m	+£32m	+£26m
Gross Value Added (GVA/year)	£118m	£245m	£336m	+£127m	+£91m

Achieving the Baseline pathway requires £779m of capital expenditure up to 2050, including already agreed policy decisions, and relates to implementation of the electricity strategy[6] (£530m), expected energy efficiency and electrification of heating in residential buildings (£237m), and provision of infrastructure to support the expected uptake of electric road vehicles (£12m). By investing up to £779m in decarbonisation (or £249m plus £530m for implementation of the electricity strategy as an agreed policy decision), Guernsey could significantly reduce its whole-Island energy spend by up to £67m each year, and add up to £118m each year to Guernsey's economy (GVA). Over the period of the Baseline pathway, this could result in up to £1,250m of energy savings and £2,200m of GVA for Guernsey's economy.

Achieving the Moderate pathway requires, over and above agreed policy decisions, additional capital expenditure totalling £493m, which mainly relates to replacing fossil-fuel heating systems in business buildings (£203m), incentivising energy efficiency measures in residential and business buildings (£116m), re-designing roads to accommodate cycle routes (£87m), introducing infrastructure to enable maritime electrification and fuel switching (£46m), procuring Micro EV cars (£20m), and introducing a small renewable fuel plant (£10m). By investing up to £1,272m in decarbonisation (or £742m plus £530m to implement the electricity strategy as an agreed policy decision), Guernsey could significantly reduce its whole-Island energy

[6] Please note that an investment in the electricity system is required regardless of pathways.

spend by up to £99m each year, and add up to £245m each year to Guernsey's economy (GVA). Over the period of the Moderate pathway, this could result in up to £1,670m of energy savings and £4,130m of GVA.

Achieving the Ambitious pathway requires, over and above the Moderate pathway, additional capital expenditure totalling £469m, which mainly relates to scaling up local renewable fuel production and increasing offshore wind (£270m), scaling up the availability of shared bikes, buses and EV cars (£170m), and introducing a water taxi service with a fixed and frequent schedule from 2035 to reduce air travel within the Channel Islands (£15m). The Ambitious pathway also requires investment associated with residential and business buildings earlier in the timeline. By investing up to £1,740m in decarbonisation (or £1,210m plus £530m to implement the electricity strategy as an agreed policy decision), Guernsey could significantly reduce its whole-Island energy spend by up to £125m each year, and add up to £336m each year to Guernsey's economy (GVA). Over the period of the Ambitious pathway, this could result in up to £2,230m of energy savings and £5,990m of GVA.

Conclusions and Recommended Pathway

Investing in carbon reduction measures and reducing emissions will deliver numerous benefits for Guernsey, and this can be achieved in a manner that enhances Guernsey's lifestyle, character and economy. Citizens could expect to benefit from warmer (in winter) and cooler (in summer) buildings, lower energy costs, an improved range of options to travel in Guernsey with improved connections to neighbouring Channel Islands, new employment opportunities in most (if not all) sectors, and improvements to the local environment (air, land and water) that is beneficial to health and wellbeing.

Working towards and achieving net zero requires jurisdictions, businesses and citizens to reduce their consumption and waste, invest in energy efficiency and electrification, and switch to using renewable fuels. The developed pathways all require significant changes to be implemented and adopted, and all developed pathways use proven carbon reduction interventions that can also enhance Guernsey's lifestyle, character and economy.

Fully implementing the developed Baseline, Moderate or Ambitious pathways would significantly reduce Guernsey's emissions by 66%, 91% or 96%, respectively, up to 2050 compared to levels recorded in 2022. All pathways suggest that Guernsey could realistically achieve its interim target of reducing emissions compared to the levels reported in 1990, and the Ambitious pathway suggests that Guernsey could achieve a higher interim ambition of reducing emissions up to 2030 and 2035. However, achieving net zero emissions by 2050 will be challenging in Guernsey. This is because space constraints in Guernsey will limit the use of the natural environment to absorb emissions, and will therefore require greater emphasis on eliminating emissions from all sectors. In the Ambitious pathway, the Waste, Agriculture and Aviation sectors are responsible for the largest sources of emissions, with 16 $ktCO_2e$ of emissions in 2050, before 5 $ktCO_2e$ of offsetting. To show how a gap of 12 $ktCO_2e$ of emissions in 2050 could be closed, examples of additional measures are summarised in Table 3, together with order magnitude level of impact. These measures were not included in the pathways, as they are not yet at a sufficient level of maturity or because they negatively impact Guernsey's current economy or circular elements of it.

Table 3: Additional carbon reduction measures

Additional Measure	Impact on Emissions	Level of Reduction in 2050
Ensure all commercial and private aircraft are electric or use hydrogen fuels, however achieving this will depend on technical advancements and international adoption	Reduce	3 $ktCO_2e$
Utilise garden waste as a feedstock in the proposed Gasification plant, however this would eliminate a locally produced source of compost	Offset	1 $ktCO_2e$
Increase woodland from 8% to 15% of Guernsey's land mass, however this may curtail the use of land for livestock and crops, or urban development	Offset	3 $ktCO_2e$
Introduce technologies to directly capture CO_2 directly from the air, however achieving this would depend on technical advancements, together with space and logistics	Offset	5 $ktCO_2e$
Participate in external carbon offsetting schemes that are certified to the highest standards, however it may not be possible to report an offset in the GHG inventory	Offset	Residual Shortfall

Achieving net zero is a global challenge. Many jurisdictions have communicated clear ambitions and targets to achieve net zero, however their plans are not fully tangible. To work towards achieving net zero emissions, **it is recommended that Guernsey adopts the Ambitious pathway**, with the Ambitious pathway requiring additional measures to achieve net zero by 2050, or sooner. By proceeding with the interventions that are proposed in the Ambitious pathway, Guernsey can enact immediate and positive action, and introduce emerging technological advancements, as they become proven and available, together with external offsetting measures as may be available and necessary.

Regardless of how a jurisdiction or citizen perceives their impact on the global climate and environment, only united action can bring about the necessary changes. Jurisdictions that do act sufficiently on their emissions will be more resilient and competitive, resulting from job creation and increased levels of trade and energy security as well as improvements environmental and public health. Jurisdictions that do not act sufficiently on their emissions should expect to become less resilient and competitive over time, and may face increasing risks related to regulatory changes and reputational damage. For Guernsey, this could mean businesses re-locating outside of Guernsey and a long-term decline in global economic trade.

DECARBONISATION PATHWAY OPTIONS FOR THE ISLAND OF GUERNSEY

2.0 Introduction

Climate change is already having visible effects on our planet. With the Earth's temperature on an upward trend, alterations in weather patterns and rising sea levels are becoming increasingly evident, and these shifts are intensifying extreme weather events such as heatwaves, floods, droughts, and wildfires. Figure 5 shows the 'warming stripes' for Guernsey, a visual representation of how temperatures have increased since the industrial revolution. The States of Guernsey's Climate Change Policy[7] sets a target for Guernsey to achieve net zero emissions by 2050, with a 57% reduction in emissions by 2030 compared to the level of emissions recorded in 1990.

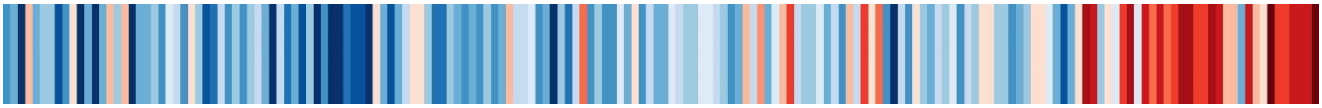


Figure 5: 'Show your stripes', Guernsey, 1843-2020

The Island of Guernsey is situated in the English Channel 43 km (27 miles) west of Normandy, France. It has an area of approximately 62 km^2 (24 square miles) and is home to approximately 64,000 inhabitants[8]. The Island forms part of the Bailiwick of Guernsey, a self-governing dependency of the British Crown, with its own parliament, government and judiciary.

The States of Guernsey commissioned Siemens, with Aether, to develop net zero pathway options in connection with Guernsey's Greenhouse Gas Inventory that reports Scope 1 and 2 emissions, and additionally consider Guernsey's impact on Scope 3 emissions in respect to visiting cruise ships, off-Island travel and exported waste.

2.1 Context and Scope

The States of Guernsey's Committee *for the* Environment & Infrastructure would like to evaluate options for achieving net zero emissions for the agreed targets in the Climate Change Policy and additionally for an increased level of ambition – achieving net zero emissions by 2040 and reducing emissions by 68% (by 2030) and 78% (by 2035) compared to the levels recorded in 1990.

The aim of this document is to set out three (3) decarbonisation pathways that will contribute positively to Guernsey's ambitions and targets in connection with its Climate Change Policy, and its commitments to the Paris Agreement. The document includes suitable interventions in connection with the pathways, together with indicative implementation costs and benefits, and other considerations to support Guernsey's decision-making process.

Three pathways are developed and presented in this document for Agriculture, Business, Electricity Supply, Residential, Transport, Waste, together with emissions from F-gases and use of the natural environment to offset emissions as follows:

- A **Baseline pathway projects Scope 1 and 2 greenhouse gas emissions up to 2050**, which assumes measures based on existing firm and funded policies and assumes anticipated trends and adoption levels.
- Based on the sectors, a **Moderate pathway option** aims to achieve net zero emissions by 2050, with a 57% reduction in emissions by 2035 compared to the levels recorded in 1990.
- Based on the sectors, an **Ambitious pathway option** aims to achieve net zero emissions by 2040, with a 68% reduction in emissions by 2030 and a 78% reduction in emissions by 2035 compared to the levels recorded in 1990.

Sectors in the developed pathways aligns with a GHG Inventory that the States of Guernsey reports every year, as follows:

- **Agriculture:** Emissions from livestock and farming activities.
- **Business:** Use of fuels in connection with space heating and business processes.
- **Electricity Supply:** Use of fuels to generate electricity on-Island and imported electricity.
- **F-gases:** Direct GHG emissions from appliances and devices used in domestic, commercial and industrial, and healthcare settings, such as refrigerants, inhalers and others.

[7] Committee *for the* Environment & Infrastructure – Climate Change Policy & Action Plan [P.2020/127]
[8] Guernsey – Facts and Figures 2023

- **Land & Forestry:** Land use management and land use change.
- **Residential:** Use of fuels in homes.
- **Transport (Aviation):** Use of fuels by commercial and private aircraft, with aviation travel between Guernsey and the UK, Jersey or Isle of Man[9].
- **Transport (Maritime):** Use of fuels by maritime vessels, including passenger ferries, cargo ships, fishing trawlers and recreational boats, that travel between Guernsey and the UK and Crown Dependencies[10].
- **Transport (Vehicles):** Use of fuels in combustion engines, such as cars, light-duty, and heavy-duty vehicles.
- **Waste Management:** Use of fuels in collecting, processing and transporting solid waste and wastewater, and emissions from the treatment and decomposition.

Emissions for each sector are based on the Scope 1 and 2 emissions that are reported in Guernsey's GHG inventory, which follows an internationally recognised methodology based on the 2006 IPCC Guidelines[11] and aligns with the UK's GHG Inventory. The following emissions are reported in Guernsey's GHG inventory (also illustrated in Figure 6):

- **Scope 1:** Direct emissions from sources and activities occurring in Guernsey, such as burning fuels to heat buildings, driving vehicles, and generating electricity at Guernsey's power plant.
- **Scope 2:** Emissions from the generation of imported electricity.
- **Scope 3 (not included in the Baseline, Moderate and Ambitious pathways):** Indirect emissions from sources that occur off-Island but are a result of on-Island activities, such as manufacture of imported goods, and onward travel after arrival in the UK. This means that embodied carbon is excluded.

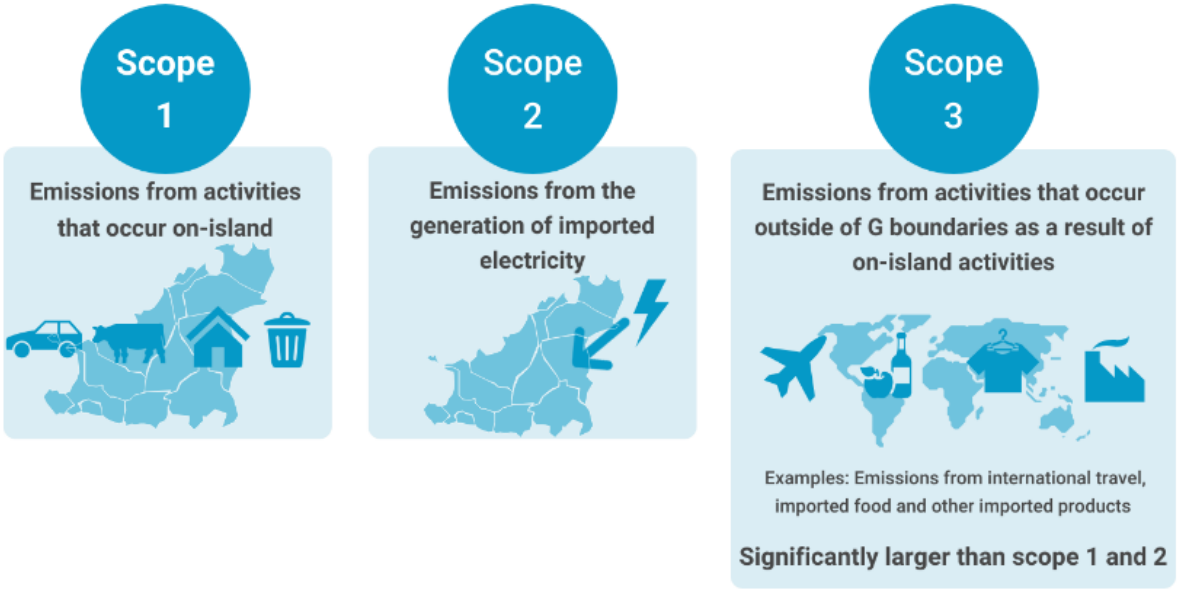


Figure 6: Scope 1, 2 and 3 definitions for Guernsey's sources of emissions

Whilst Scope 3 emissions are not included in the developed pathways, section 3.10 in this document estimates emissions outside of Guernsey's jurisdiction for food waste exported to the UK, solid waste exported via the UK to Scandinavia for incineration, and visiting cruise ships.

Necessary carbon reduction interventions to achieve the developed pathways are set out in section 5.0, indicative and comparative costs, and benefits to achieve each option are set out in sections 4.2 and 4.3, respectively, and a recommended scenario with justification and high-level roadmap, based on the techno-economic analysis, is provided in section 6.0.

[9] As Guernsey's GHG emissions inventory is reported as part of the UK's, 'domestic' travel also includes travel between Guernsey and the UK, other Crown Dependencies and Overseas Territories signed up to the Kyoto Protocol (and now the Paris Agreement). For domestic aviation, emissions are attributed to the place of departure. Travel between Guernsey and France is therefore considered international travel and is reported in the GHG inventory for information only. The level of emissions for international travel is therefore out of scope. However, an estimation of the emissions associated with visiting cruise ships is estimated.
[10] As with aviation, only domestic maritime travel is accounted for in the inventory which includes travel between Guernsey and the UK and Crown Dependencies. Emissions are allocated to the place of arrival.
[11] 2006 IPCC Guidelines for National Greenhouse Gas Inventories

2.2 Strategic Objectives and Success Factors

Working to mitigate the effects of and adapting to the impacts of climate change is a global challenge, and the need for urgent and meaningful action on climate change is widely recognised. Decarbonisation requires communities to accept and make meaningful changes, and transition away from using fossil fuels toward electrification technologies and renewable fuels.

Decarbonisation is a collective endeavour that necessitates all countries and individuals to reduce their consumption and waste, invest in energy efficiency and electrification, and switch to using renewable fuels. Regardless of how a country or person perceives their emissions impact, only united action can bring about the necessary change to curb the severe effects of climate change.

The States of Guernsey's Climate Change Policy[12] sets a target for Guernsey to be net zero by 2050, with an interim target of reducing emissions by 57% on 1990 levels by 2030. It also seeks to monitor annual emissions, including Scope 3 emissions relating to exported waste, off-island travel and visiting cruise ships.

In addition, the Paris Agreement[13] has been formally extended to Guernsey at the 28th Conference of the Parties (COP28). The aim of the Paris Agreement, which is a legally binding international treaty on climate change, is to hold the increase in global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels[14]. A 5-year cycle is used to set increasingly ambitious climate actions.

An optimal decarbonisation strategy for Guernsey should facilitate continued trade, stimulate economic growth, and enhance Guernsey's reputation by aligning with the targets set by the Paris Agreement. Furthermore, it should:

- Be economically viable, ensuring that financial responsibility does not solely rest on the government.
- Promote a circular economy, which encourages the use of precious local resources.
- Unlock broader societal advantages, including health improvements and environmental enhancements.

The success factors for the pathways considered in this document focus primarily on the States of Guernsey's set emission targets and key dates, and the United Nations' seventeen (17) Sustainable Development Goals, which seek to promote global peace, prosperity and environmental sustainability[15], is used as a guiding refence, as pictorially represented in Figure 7.

Figure 7: UN – Action 2030 – 17 Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) address urgent challenges and call for action by all countries, both developed and developing, as follows:

- **No Poverty (SDG 1):** End poverty in all its forms
- **Zero Hunger (SDG 2):** Achieve food security, improve nutrition and promote sustainable agriculture
- **Good Health & Well-being (SDG 3):** Ensure healthy lives and well-being for all

[12] States of Guernsey - Climate Change Policy & Action Plan – P.2020/127
[13] International Agreements - States of Guernsey (gov.gg)
[14] The Paris Agreement | UNFCCC
[15] United Nations Sustainable Development

- **Quality Education (SDG 4):** Ensure inclusive and equitable education for all
- **Gender Equality (SDG 5):** Achieve gender equality and empower women and girls
- **Clean Water & Sanitation (SDG 6):** Ensure access to clean water and sanitation for all
- **Affordable and Clean Energy (SDG 7):** Promote sustainable energy sources
- **Decent Work & Economic Growth (SDG 8):** Foster inclusive economic growth and decent work opportunities
- **Industry, Innovation & Infrastructure (SDG 9):** Build resilient infrastructure and promote sustainable industrialisation
- **Reduced Inequalities (SDG 10):** Reduce inequalities within and among countries
- **Sustainable Cities & Communities (SDG 11):** Create inclusive, safe and resilient cities
- **Responsible Consumption & Production (SDG 12):** Promote sustainable consumption and production patterns
- **Climate Action (SDG 13):** Take urgent action to combat climate change and its impacts
- **Life Below Water (SDG 14):** Conserve and sustainably use oceans, seas, and marine resources
- **Life on Land (SDG 15):** Protect, restore, and promote sustainable use of terrestrial ecosystems
- **Peace, Justice & Strong Institutions (SDG 16):** Promote peaceful and inclusive societies, provide access to justice and build effective institutions
- **Partnerships for the Goals (SDG 17):** Strengthen global partnerships to achieve the SDGs

2.3 Comparison with Other Jurisdictions

Many jurisdictions have ratified or acceded to the Paris Agreement, and many of those jurisdictions have set Climate Change Plans, which typically include policies and proposals to achieve net zero emissions by 2050, with interim targets relative to a baseline year. The Crown Dependencies of Jersey and Isle of Man, for example, have both ratified the Paris Agreement and therefore have legally binding climate targets[16-17].

In accordance with the Paris Agreement, **Jersey** has pledged to reach net zero by 2050, and reduce emissions by 68% (by 2030) and 78% (by 2035) compared to its 1990 baseline. In 2022, the States of Jersey published its strategic plan and roadmap[18] to work towards achieving net zero emissions. The roadmap presents multiple pathways to net-zero and is structured around four key areas: 1) Transport; 2) Heating; 3) Cooking and Cooling; and 4) On/off-Island Emissions, and identifies enabling policies, together with mitigation actions across various sectors and facilitative measures such as skills gap analysis, climate financing and climate education.

In accordance with the Paris Agreement, **Isle of Man** has pledged to reach net zero by 2050, and reduce emissions by 35% (by 2030) and 45% (by 2035) compared to a 2018 baseline. In 2022, the Isle of Man published its Climate Change Plan (2022-27)[19], which includes policies, proposals and actions to mitigate emissions across all sectors. The plan is structured around the inventory sectors but also outlines linkages with five broader themes: 1) Adaptation and resilience; 2) Fair change; 3) Leading by example; 4) Investing in the future; and 5) Engagement and awareness, and includes linkages to wider SDGs.

Comparison between Guernsey, Jersey and Isle of Man

Guernsey's scope 1 emissions (therefore excluding emissions from imported electricity[20]) in 2022 were the smallest of the three Crown Dependencies, at 299 $ktCO_2e$ compared to 351 $ktCO_2e$ for Jersey and 521 $ktCO_2e$ for Isle of Man. However, on a per-capita basis, Jersey's emissions were the smallest of the three Crown Dependencies, at 3.4 $ktCO_2e$/capita compared to 4.7 $ktCO_2e$/capita for Guernsey and 6.2 $ktCO_2e$ for the Isle of Man.

Based on the sources of GHG emissions reported by Guernsey, Jersey and Isle of Man, Guernsey has relatively high emissions from the Waste and Business sectors; Jersey has relatively high emissions from the Transport sector; and the Isle of Man has relatively high emissions from the Energy and Agriculture emissions, together with relatively high off-setting from the natural environment. A comparison of the sources of emissions in Guernsey, Jersey and Isle of Man are presented in Table 4, together with an overview of each sector further below.

[16] Paris Agreement extended to Jersey
[17] Paris Agreement extended to Guernsey
[18] Jersey's Carbon Neutral Roadmap
[19] Isle of Man Climate Change Plan 2022-2027
[20] Guernsey Annual Greenhouse Gas Bulletin 2022

Table 4: Split of emissions by sector for each of the Crown Dependencies

Sector	Guernsey	Jersey	Isle of Man
Agriculture	5%	6%	21%
Business (Including Industrial Processes)	14%	9%	6%
Electricity Supply	8%	8%	32%
F-gases	5%	6%	3%
Land & Forestry	-1%	0%	-14%
Residential	21%	22%	23%
Transport	33%	45%	28%
Waste Management	14%	5%	1%
Total	**100%**	**100%**	**100%**

Agriculture and land use: Agriculture sector emissions account for 5% of Guernsey's, 6% of Jersey's, and 21% of the Isle of Man's total emissions. The Isle of Man's higher emissions are due to its larger non-cattle dairy numbers (~20,000) compared to Guernsey (300) and Jersey (1,900). Despite cattle being a larger emissions source than sheep, the Isle of Man's substantial sheep population (123,000) also contributes to its high agricultural emissions, compared to Guernsey (~250) and Jersey (~600). The Isle of Man's Climate Plan proposes improving baseline agricultural emissions for accurate monitoring of strategy impacts, and a Blue Carbon Strategy.

Business (Including Industrial Processes): Business sector emissions account for 14% of Guernsey's, 9% of Jersey's, and 6% of the Isle of Man's total emissions. This would suggest that Guernsey's business sector is using greater amounts of fuel relative to Jersey and the Isle of Man.

Electricity Supply: Electricity supply sector emissions account for 8% of Guernsey's, 8% of Jersey's, and 32% of the Isle of Man's total emissions. The Isle of Man's electricity supply emissions arise from the use of on-Island thermal generation, using conventional fuels, to meet 84% of the Island's electricity needs. This compares to Jersey and Guernsey that import most of their electricity needs from France via interconnection. The Isle of Man's Climate Change Plan outlines deliverables to reach net zero energy supply in an affordable and secure way, and a Buildings chapter covering decarbonisation of the residential sector outlines a range of strategies, incentivising efficiency measures and implementation of policy and legislation to decarbonise the sector.

F-gases: The proportions of emissions arising from F-gases are comparable across the Crown Dependencies.

Land & Forestry: Sequestered emissions from the natural environment account for -1% of Guernsey's, 0.2% of Jersey's, and -14% of the Isle of Man's total emissions. The Isle of Man sequesters more carbon than Jersey and Guernsey due to extensive natural land availability, especially forests and grasslands converted from croplands. To offset emissions, the Isle of Man Government Action Plan includes a local scheme that funds carbon sequestration projects, initially counterbalancing personal and business flights. The Isle of Man's Climate Plan proposes a Land Management Plan that includes nature-based solutions like peatland restoration (leveraging private sector investment), and a Blue Carbon Strategy.

Residential: The proportions of emissions arising from the Residential sector are comparable across the Crown Dependencies.

Transport: Transport sector emissions account for 34% of Guernsey's, 45% of Jersey's, and 28% of the Isle of Man's total emissions. Transport is the largest source of emissions in Jersey, and its Carbon Neutral Roadmap prioritises a particular focus on road transport through actions such as incentivising EV use. Additionally, decarbonisation of maritime and aviation sectors is considered in the roadmap, such as increasing the use of sustainable aviation fuel (both synthetic and bio) across 2030-2040, however the roadmap states these actions are imagined scenarios rather than predictions. The Isle of Man's Climate Change Plan largely relate to road transport, however a more detailed scoping of the decarbonisation options for the transport sector (covering road, maritime and aviation sectors) are outlined in the Isle of Man's Transport Decarbonisation Scenarios report, published in June 2024[21].

Waste Management: Waste sector emissions account for 14% of Guernsey's, 5% of Jersey's, and 1% of the Isle of Man's total emissions. The Jersey and the Isle of Man use Energy Recovery Facilities (ERF) to dispose of their waste, which results in lower

[21] Isle of Man Decarbonisation Scenarios

emissions than Guernsey where waste was historically sent to landfill. Whilst Jersey does not typically produce emissions related to waste disposal as there is no landfill on-Island and the ERF is used to dispose of generated waste, waste disposal emissions were reported for the first time in 2021 and 2022 due to a temporary shutdown of the ERF.

Achieving Net Zero Emissions

Jersey's Carbon Neutral Roadmap outlines decarbonisation strategies for various sectors, including aviation, maritime transport, blue carbon, afforestation, waste carbon capture, agriculture, construction, scope 3 emissions, large-scale renewables, and offsets. Its roadmap includes "imagined scenarios, and not predictions", indicating potential rather than certain outcomes. The agriculture sector lacks specific practices to achieve a 36% emission reduction, instead suggesting a need for ongoing research and implementation of practices to reduce or capture GHG emissions. High-quality offsets are considered for residual emissions.

The Isle of Man's Climate Change Plan outlines decarbonisation strategies for various sectors including electricity, buildings, transport, agriculture, land and sea, business and waste. The plan does not include emissions pathways to show the projected impact of actions on GHG emissions but does reference specific strategies e.g. Agricultural Strategy, Waste Management and Circular Economy Strategies, which are in place or planned to reach target reductions across those sectors.

In summary, net zero strategy implementation is a global challenge that every jurisdiction faces. In 2023, the UK's High Court ruled that the UK government's action plan is unlawful due to insufficient policies to reduce greenhouse gas emissions in their carbon budget delivery plan[22]. In 2021, the International Energy Agency published a roadmap outlining how the global energy system can reach net zero by 2050[23], and the IEA stated that almost half the reductions in 2050 come from technologies that are currently at the demonstration or prototype phase. All jurisdictions will therefore depend on major innovation efforts and substantial technology development to support their net zero roadmaps up to 2050.

2.4 Pathway Development Process based on Guernsey's Greenhouse Gas Inventory

The development of the Baseline, Moderate and Ambitious pathways up to 2050 presents emissions in the same way as the emissions reported in **Guernsey's GHG inventory**, which is updated annually, and the latest version shows the change in emissions from 1990 to 2022[24]. The inventory contains emission estimates categorised by sector, summarised in Table 5.

Table 5: Summary of Guernsey's emission sources by sector.

Inventory Sector	Sector categories used in this study	Coverage

Agriculture	Agriculture	• Livestock (cattle, pigs, sheep, horses, goats, poultry):
		  • Manure management
		  • Enteric fermentation (digestion)
		• Agricultural soils
		• Liming application
		• Urea application

Business	Business (including Industrial Processes)	• Fuel use (gas oil, burning oil/kerosene) • Process emissions from the consumption of aerosol cream (allocated under Industrial Processes in inventory)
Energy supply	Electricity supply	• Imported electricity via interconnector (not accounted for in Guernsey's GHG inventory) • On-island generation (fuel oil and gas oil)
Industrial Processes	Considered under Business	
Land use, land use change and forestry (LULUCF)	Land & Forestry	• Cropland • Forest land • Grassland • Settlements • Accounts for emissions associated with conversion from one land use type to another
Business, Residential	F-gases	• HFCs from refrigeration in commercial & industrial and residential buildings • HFCs from air conditioning units in commercial & industrial and residential buildings and vehicles

[22] Britain's climate plan unlawful, high court rules
[23] IEA Net Zero by 2050: A Roadmap for the Global Energy Sector
[24] Guernsey Annual Greenhouse Gas Bulletin 2022

		• HFCs from miscellaneous sources such as fire extinguishers, metered dose inhalers and heat pumps in both commercial & industrial and residential sectors • Emissions allocated under Business and Residential categories in line with the existing GHG inventory
Residential	Residential	• Fuel use (gas oil, burning oil/kerosene, LPG)
Transport	Transport	• Road transport (cars, LGVs, buses and coaches, rigid HGVs, mopeds, and motorcycles) • Domestic aviation (split by fuel use: aviation turbine fuel, aviation spirit, and sustainable aviation fuel) • Domestic navigation (split into shipping – coastal (fuel oil), shipping - coastal (gas oil), and fishing vessels)
Waste Management	Waste Management	• Landfill • Composting (at permit sites) • Incineration – clinical waste • Sewage sludge decomposition

Note: See section 2.1 Context and Scope for the definitions of domestic and international aviation and navigation.

Under the Paris Agreement reporting requirements, estimates of seven (7) greenhouse gases are required, which absorb and reflect energy at different rates, and therefore cause differing levels of temperature increase. The relative temperature increase, known as Global Warming Potential (GWP), is used to standardise the warming impact across the different gases. As carbon dioxide is the most abundant GHG, it is given a GWP of 1. Methane, for example, is 28 times more potent than carbon dioxide so it is given a GWP of 28. The use of GWPs allows the warming impact of several GHGs to be standardised and reported as one value expressed as a carbon dioxide equivalent, CO_2e.

For Guernsey, both the historic emissions and projected emissions under the Baseline, Moderate and Ambitious pathways are presented in CO_2e, which estimates the level of the following greenhouse gases:

- **Carbon dioxide (CO_2):** Carbon dioxide is the most significant greenhouse gas emitted in Guernsey. Total emissions are dominated by those from power stations, refineries and other users of fossil fuels (including transport, domestic and industrial sectors). Greenhouse gas fluxes from LULUCF can contribute to both emissions and sinks i.e. negative emissions. The total contribution to GWP weighted greenhouse gas emissions in Guernsey is 76% in 2022.
- **Methane (CH_4):** Methane is the second most significant greenhouse gas in the UK after CO_2. The major emitting sources in recent years are enteric fermentation, landfilling of wastes, and leakage from the gas distribution system. The total contribution to GWP weighted greenhouse gas emissions in Guernsey is 17% in 2022.
- **Nitrous oxide (N_2O):** Nitrous oxides are the third most abundant GHG in Guernsey. N_2O emissions come from a range of sources including clinical waste incineration, agricultural soils (due to fertiliser usage), and domestic wastewater treatment. The total contribution to GWP weighted greenhouse gas emissions in Guernsey is 3% in 2022.
- **Hydrofluorocarbons (HFCs):** HFC emissions can arise from the manufacture of halocarbon chemicals including HFCs themselves, and from the use of HFCs for various purposes, including as replacements for ozone depleting substances. Refrigeration and air conditioning (RAC) use is the largest source and contributed almost all (99.8%) of total HFC emissions in 2020 in the UK. Emissions from HFC use in RAC arise due to leakage from refrigeration and air conditioning equipment during its lifetime, in their manufacture and during the recovery of the refrigerants on decommissioning. Hydrofluorocarbons have a range of global warming potentials (GWP), which are much higher than that of carbon. However, the small quantities emitted mean that despite the high GWP values of the individual gases, the total contribution to GWP weighted greenhouse gas emissions in Guernsey is small (5% in 2022).
- **Perfluorocarbons (PFCs):** As with HFCs, perfluorocarbons also have a range of GWPs. The electronics industry is now the greatest contributor to emissions of PFCs in the UK since the decline of the aluminium industry.
- **Sulphur hexafluoride (SF_6):** Sulphur hexafluoride has a very high radiative forcing effect with emissions occurring due to its use in a small number of applications in the UK, the largest of which being electrical insulation.
- **Nitrogen trifluoride (NF_3):** Weighted GHG emissions of nitrogen trifluoride is very small despite its high radiative forcing, with its use in electronics being the greatest source in the UK.

HFCs, PFCs and SF_6 are collectively referred to as 'F-gases'. All gases aside from SF_6 and NF_3 are included in Guernsey's inventory. SF_6 and NF_3 are not reported as it is assumed that there is no activity in Guernsey, which would result in these emissions. PFCs were emitted between 1995 and 2009, however the activity has since ceased.

Using Guernsey's GHG inventory as a starting point, a **discovery process** involved additional data collection, literature review and stakeholder interviews. A **Baseline pathway** was created, which estimated the level of Scope 1 and 2 CO_2e emissions up to 2050 and identified to what extent Guernsey could achieve the Climate Change Policy targets. Assuming measures based

on existing firm and funded policies and anticipated trends and adoption levels, the Baseline pathway assumed growth in emissions from the effects of economic and population growth, and additionally assumed reductions in emissions due to the expected adoption of electric vehicles and heating, declining emissions from the historical use of landfill, and decarbonisation of the electricity supply.

An **optioneering process** then explored several decarbonisation topics, with online workshops used to discuss opportunities for on- and off- Island modes of travel and transport, switching to and producing alternative fuels, and offsetting emissions using the natural environment and technologies. Possible ideas to reduce emissions were tested in workshops, which included representation from States of Guernsey and Energy Partnership stakeholders and informed the development of two additional pathways up to 2050, which aim to reduce GHG emissions across all sectors and determine the potential level of GHG abatement up to 2050, and when it could be possible to achieve net zero emissions.

In developing the pathway options, valuable inputs were gained through the diverse interactions with identified stakeholders, both within the States of Guernsey and involved in the Energy Partnership. The domain experts provided insights into the practical challenges and opportunities that helped identify practices and policies in place and areas needing improvement. These collaborative efforts aimed to explore realistic and effective interventions tailored to the unique characteristics and constraints of Guernsey, and considered:

- **Land Availability:** The limited land on the island necessitates careful planning to optimize space for new developments, and the introduction of necessary infrastructure.
- **Noise Pollution:** Interventions must comply with noise guidelines to ensure minimal disruption to residents, particularly in densely populated areas (e.g., air source heat pump installations near neighbouring properties).
- **Financial Possibilities:** The economic feasibility of proposed measures is crucial. Solutions must be cost-effective and financially accessible to a broad range of stakeholders, including homeowners, businesses, and the local government.
- **Citizen Awareness and Readiness:** Understanding the public's awareness of environmental issues and their willingness to adopt new practices is essential for the success of any intervention. This includes educational campaigns and incentives to encourage energy-efficient practices and technologies, and communication of long-term benefits and availability of financing arrangements.
- **Other:** Included topics such as conservation, lack of information regarding the condition of building stock, and insight to ongoing implementations.

Suitable interventions were selected for the **Moderate and Ambitious pathways**, with an aim to achieve net zero emissions and interim target reductions in emissions compared to the levels recorded in 1990. Interventions were then selected and defined along with the nature, magnitude and timing of changes required, and mapped to the decarbonisation pathways. Additionally, indicative costings were identified for the interventions, together with the benefits and key dependencies associated with their implementation and adoption.

DECARBONISATION PATHWAY OPTIONS FOR THE ISLAND OF GUERNSEY

3.0 Baseline Pathway for the Island of Guernsey

Between 1990 and 2022, Guernsey's emissions reduced from 561 $ktCO_2e$ to 300 $ktCO_2e$, a 46.5% reduction. In absolute terms, the largest reductions occurred due to decarbonisation of electricity supply (-122 $ktCO_2e$), reduced use of fossil-fuels for residential, commercial and industrial combustion (-79.2 $ktCO_2e$), reduced use of petrol and diesel for road vehicle transport (-50.4 $ktCO_2e$), and reduced use of landfill for waste (-27.8 $ktCO_2e$). Over the same period, emissions increased in connection with agricultural activity (+5.9 $ktCO_2e$) and use of F-Gases (+13.8 $ktCO_2e$).

The largest change occurred in the electricity supply sector, where emissions decreased by 83%, from 147 $ktCO_2e$ in 1990 to 25 $ktCO_2e$ in 2022 (including scope 2 emissions from imported electricity). This was driven by the introduction of the interconnector in 2000, enabling Guernsey to import low-carbon electricity, largely generated via nuclear power stations, from France. This reduces the quantity of on-Island generation required to meet demand, which is generated by combusting carbon intensive gas oil and fuel oil.

In the residential sector, emissions reduced by 44% between 1990 and 2022. This was driven by a reduction in LPG usage across this period from 3.9 Mth in 1990 to 1.9 Mth in 2022, which is most likely due to a combination of electrification and efficiency improvements. Over the same period, there was a 20% reduction in emissions from the commercial and industrial sectors. This was primarily driven by a 5.7 kt reduction in the mass of kerosene fuel used in the commercial sector (categorised in the inventory under 'Other industrial combustion' in the Business sector) across this period.

A 34% reduction occurred in transport emissions between 1990 and 2022. Whilst the number of road vehicles in Guernsey did increase over the period, a 39% decrease in fuel consumption (34% decrease in petrol consumption, 45% decrease in diesel consumption) was mainly due to the fuel-efficiency improvements of newer Internal Combustion Engine (ICE) vehicles that have needed to meet stricter emission standards.

Finally, a 40% reduction occurred in total emissions from the waste management sector between 1990 and 2022, largely driven by a reduction in landfill emissions, from 64.7 $ktCO_2e$ to 34.8 $ktCO_2e$. An estimated 57 kt of waste was disposed to Mont Cuet landfill in 1990, which gradually decreased to 27 kt in 2018, and the implementation of Guernsey's Waste Strategy resulted in only 4 kt of degradable waste disposed at Mont Cuet in 2019. Instead, in 2019, 5.33 kt were exported for off-Island energy recovery and 16.65 kt were recycled (including green waste and food waste). In 2022, waste quantities further reduced to 3.76 kt to landfill. Whilst there has been a recent reduction in the quantities of waste sent to landfill, emissions savings can take some time to be realised due to the lag time in methane generation for historical landfill activity.

Conversely, agriculture emissions increased due to a 24% increase in dairy cattle numbers, from 1,861 in 1990 to 2,310 in 2022, and F-gas emissions increased significantly from 1990 due to their widespread use as substitutes for ozone-depleting substances. Although the level of F-gas emissions in Guernsey has steadily decreased from 2013, the reported level in 2022 remains 169,000% higher compared to 1990, and the primary reason is due to its use in coolant liquids used in refrigeration and air conditioning equipment.

It should be noted that the 2022 emissions presented in this report differ slightly compared to the 1990 – 2022 inventory calculated by Aether in the publicly available Guernsey's Annual Greenhouse Gas Bulletin[25]. The difference is for two reasons:

- **Inclusion of imported electricity**: In accordance with national inventory reporting requirements, emissions from electricity production are attributed to the country that produces the electricity. As such, Guernsey's published GHG inventory represents scope 1 emissions from on-Island electricity generation and does not account for scope 2 emissions from the imported electricity. The scope of this work includes the imported electricity as it forms an important part of Guernsey's electricity supply and strategy.
- **Reduction in cattle livestock numbers**: In Guernsey's published GHG inventory, the dairy cattle and other cattle numbers used to estimate agriculture emissions represent cattle numbers from the Bailiwick of Guernsey. The scope of this work focuses on modelling net zero scenarios for the Island of Guernsey, and as such the livestock emissions were reduced to reflect activity only on the Island of Guernsey.

It should be noted that this report estimates Guernsey's impact on emissions outside of its jurisdiction in relation to exported waste and visiting cruise ships, however these emissions are not included in the GHG inventory or the developed pathways.

Figure 8 compares Guernsey's greenhouse gas emissions by sector in 1990 and 2022.

[25] Guernsey Annual Greenhouse Gas Bulletin 2022

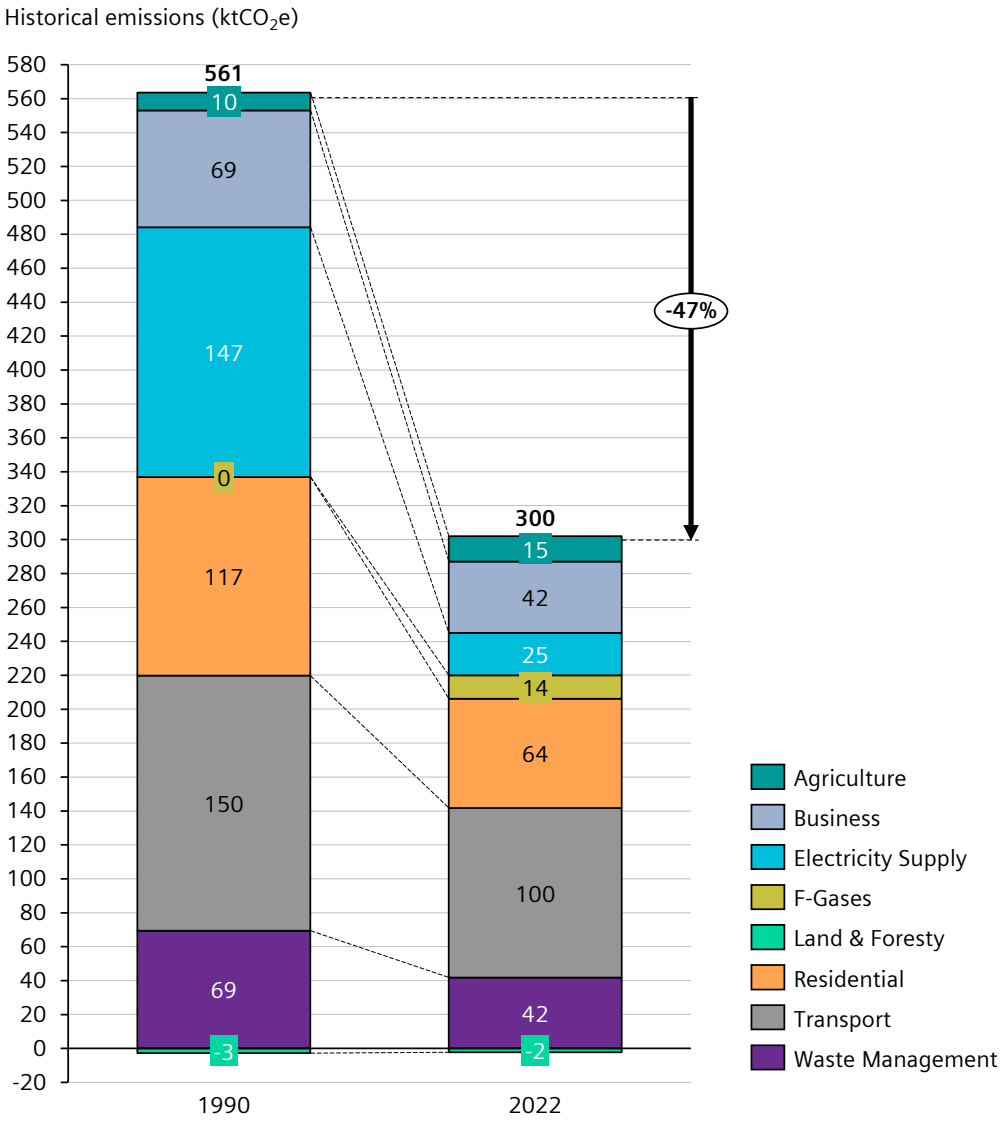


Figure 8: Guernsey's greenhouse gas emissions by sector, 1990 and 2022

3.1 Baseline Projection up to 2050

Under the Baseline pathway, emissions are estimated to reduce 66% from 300 $ktCO_2e$ to 101 $ktCO_2e$ by 2050 (see Figure 9).

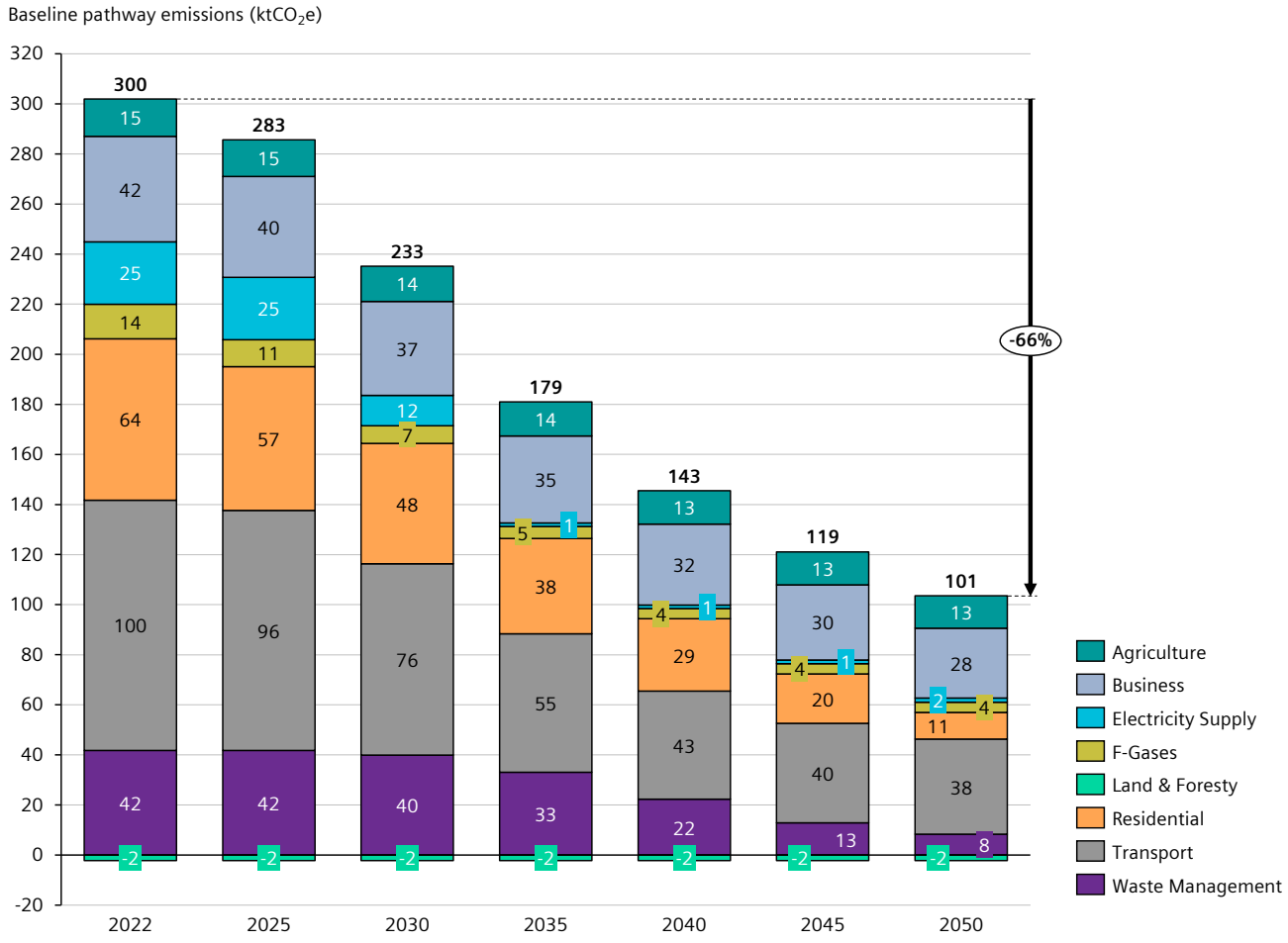


Figure 9: Projected emissions for the Baseline pathway (2022 – 2050)

The largest reduction can be seen in the electricity supply sector, where emissions reduce 93% by 2050. This is due to the planned implementation of the Island's Electricity Strategy[26], which will increase the amount of low carbon electricity supplied from 2030 via an additional interconnector, an offshore windfarm and on-Island solar PV. For the Baseline pathway, information on the interventions in each sector and their emission reduction impact is presented in sections 3.2 – 3.7, and a summary is as follows:

- **Agriculture & Land Use:** Dairy cattle emissions decrease by 1% annually up to 2035 and 0.5% thereafter to reflect efficiency gains, and existing levels of woodland actively managed and preserved.
- **Business (Including Industrial Processes):** Use of gas oil and kerosene decreases by 41% and 32%, respectively, up to 2050 in line with historical trend.
- **Electricity Supply:** A new interconnector is introduced between Guernsey and France by 2030 and an offshore wind farm is introduced in Guernsey's waters by 2035.
- **F-gases:** Decreases at the same assumed rate in the CCC's Sixth Carbon Budget assumptions for the UK, by implementing the retained F-gas Regulation ((EU) no.517/2014).
- **Residential:** Electric heating adoption increases from 30% to 90% in all homes up to 2050.
- **Transport:** The adoption of Electric Vehicles (includes all cars and Light Goods Vehicles (LGVs), and all buses and Heavy Goods Vehicles (HGVs) later in the period) increases from 4% to 95% up to 2050, and conventional fuels continue to be used for aircraft and marine vessel journeys.

[26] States of Guernsey - Electricity Strategy

- **Waste (Including Wastewater):** Emissions from the historical use of landfill start to decline from 2028, reducing from 35 $ktCO_2e$ to 1 $ktCO_2e$ by 2050, and wastewater continues to be screened and discharged into the sea.

The investment required for the Baseline pathway up to 2050 is estimated to be in the region of £779m, as shown in Table 6, and mainly relates to implementation of the electricity strategy, incentives for electrification of heating in residential buildings, and infrastructure for the electrification of road vehicles.

Table 6: Investment in the Baseline pathway by sector

Sector	Investment in Baseline Pathway (£m)	Emission Reduction by 2050 in Baseline Pathway ($ktCO_2e$/year)
Agriculture	-	2.0
Business (Including Industrial Processes)	-	14.2
Electricity Supply	530	23.3
F-gases	-	9.7
Land & Forestry	-	-
Residential	237	53.8
Transport (Aviation)	-	-
Transport (Maritime)	-	-0.7
Transport (On-Island Travel)	12	62.7
Waste Management	-	33.4
Total	**779**	**198.4**

3.2 Agriculture

Agricultural emissions in Guernsey come from a range of sources, which include livestock emissions (enteric fermentation and manure management), agricultural soils and fertiliser application, liming, and urea consumption. The agricultural sector was responsible for 5% (15 $ktCO_2e$) of Guernsey's total GHG emissions in 2022, of which 72% were related to dairy cattle. The remaining emissions occur from activities relating to non-dairy cattle and other livestock, and from agricultural soils and use of fertilisers.

Emissions from agriculture are not expected to change significantly between 2022 and 2050 under the Baseline pathway, although a small reduction of 2$ktCO_2e$ is projected. This assumes that Guernsey will continue to meet demands for dairy products whilst adopting more efficient dairy production processes that require fewer cattle herd over time for the same output. Dairy cattle emissions are estimated to decrease by 1% annually up until 2035 and 0.5% thereafter to reflect efficiency gains. All other livestock emissions are assumed to remain constant, as are other agricultural emissions from fertiliser, urea and liming.

For the Baseline pathway, Figure 10 shows the composition of emissions for the Agriculture sector, together with the current and forecasted level of emissions up to 2050.

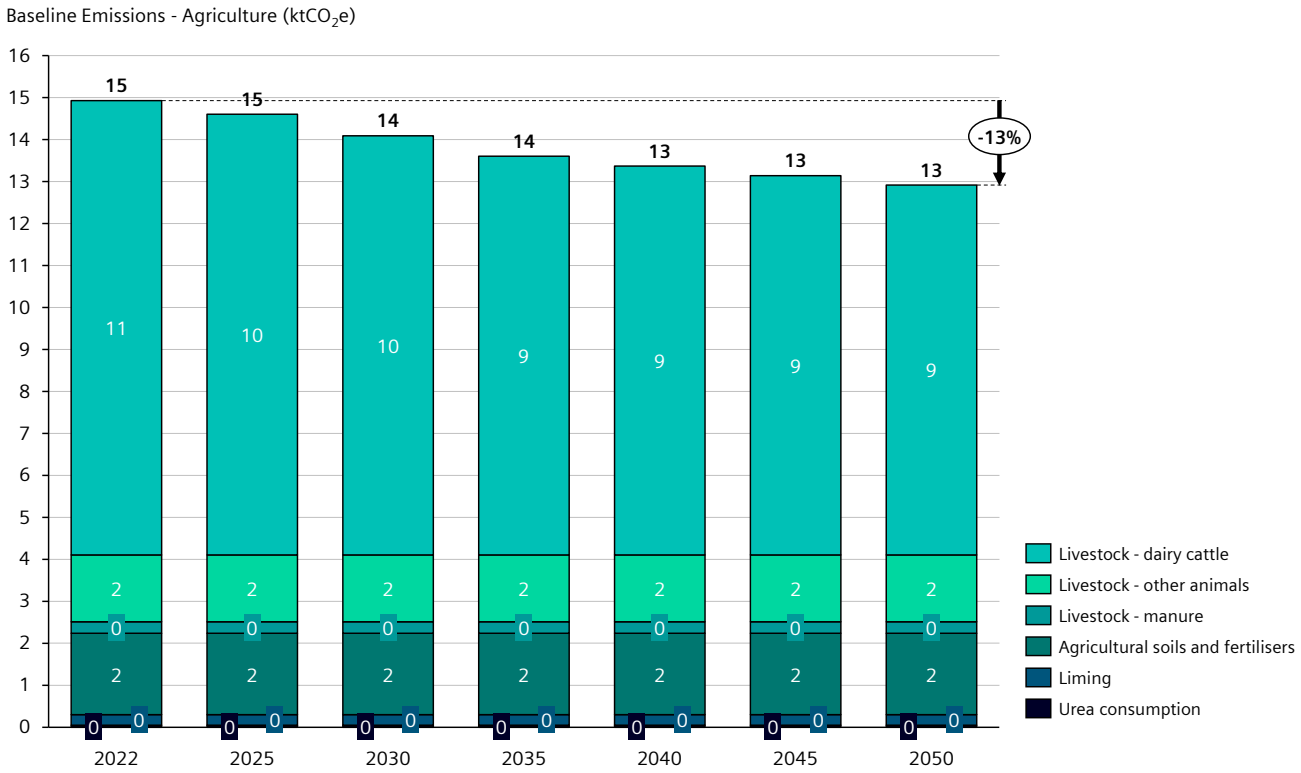


Figure 10: Baseline pathway emissions – Agriculture

3.3 Business (Including Industrial Processes)

Guernsey's total Gross Domestic Product (GDP) for 2022 was estimated at £3,349 million, and GDP per capita at £52.8k[27]. The financial and insurance activities sector contributes significantly to GDP, accounting for £1,282 million (38% of total GDP) in 2022, and when associated professional services are included, the total reaches £1,495 million (45% of total GDP). In contrast, activities associated with manufacturing, agriculture, forestry, fishing, mining and quarrying collectively account for only 1.5% of Guernsey's total GDP.

The Business sector is responsible for emissions from the use of fuels for space heating and business processes, and businesses may operate from offices, warehouses, retail shops, and hospitality. Emissions from the buildings and processes of businesses are mostly due to the use of kerosene and gas oil for HVAC applications. Longue Hougue is a key location for existing industrial activities, which includes waste processing and transfer facilities, and it is planned to locate future industrial developments and strategic infrastructure there. Local quarrying and activities associated with producing materials for construction are other notable economic sectors, which contribute to emissions.

The use of gas oil and kerosene has historically reduced by 2% and 1.4%, respectively, each year, while the level of N_2O emissions has remained relatively stable. In developing the Baseline pathway, emissions are projected to continue decreasing in line with historical trends up to 2050, which is assumed to be driven by a continued increase in energy efficiency through natural replacement and does not consider additional levels of electrification. Hence, a reduction of 14 $ktCO_2e$ (or 34%) is expected by 2050.

The inventory also includes a small quantity of N_2O emissions, which is attributed to a propellant in the use of medical devices and consumption of dairy cream in aerosol canisters, and emissions are expected to increase with the population level up to 2050.

For the Baseline pathway, Figure 11 shows the composition of emissions for the Business sector, together with the current and forecasted level of emissions up to 2050.

[27] States of Guernsey – Annual GVA and GDP Bulletin

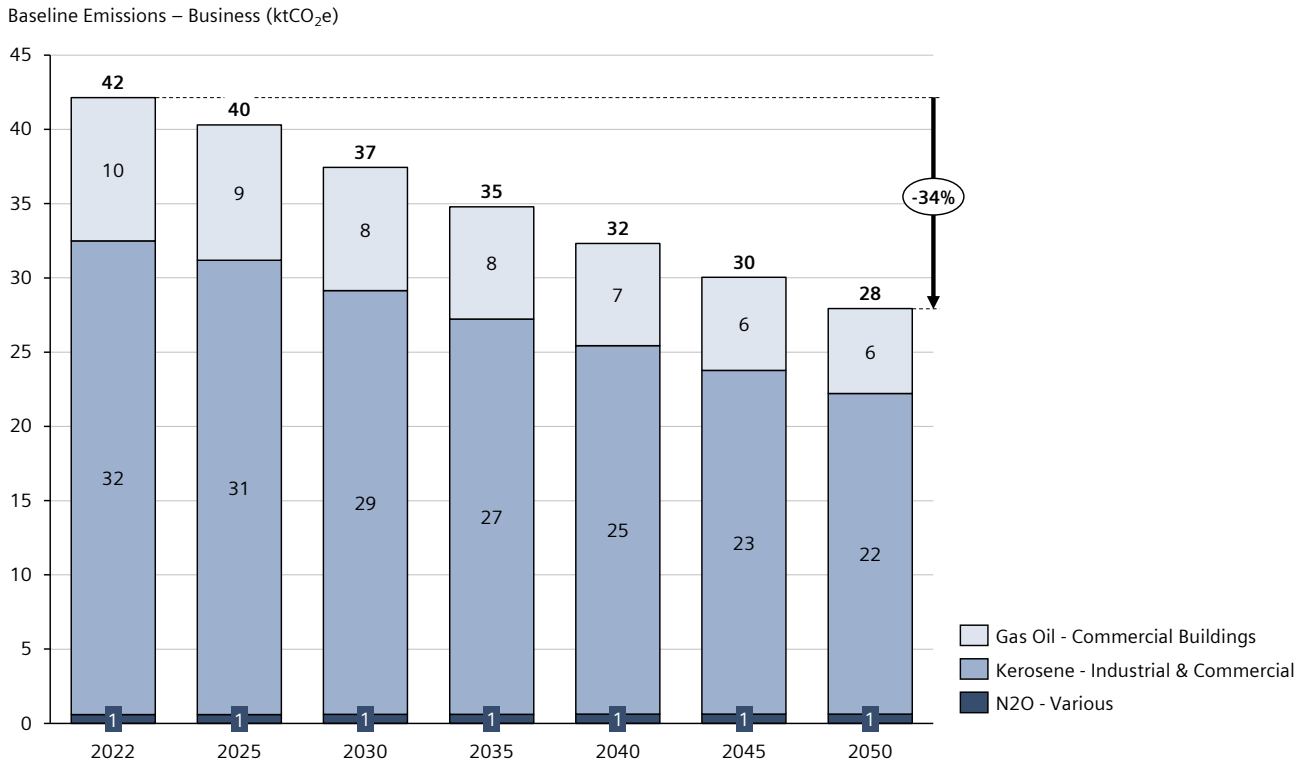


Figure 11: Baseline pathway emissions – Business (including industrial processes)

3.4 Electricity Supply

In 2022, the generation and import of electricity made up 8% of Guernsey's total Scope 1 and 2 GHG emissions. The largest proportion of the 25 $ktCO_2e$ emitted came from the use of the on-Island thermal power plants that burn Heavy Fuel Oil (HFO) to generate electricity, i.e. 76% or 19 $ktCO_2e$. The second largest proportion arose from the on-Island thermal power plants that burn gas oil to generate electricity, i.e. 16% or 4 $ktCO_2e$. The imported electricity via the Guernsey-Jersey interconnector (GJ1) had comparatively the lowest GHG emissions with 2 $ktCO_2e$.

It is worth noting that the quantity of emissions is not directly proportionate to the amount of electricity generated by each of the three types, as the carbon intensity factors vary significantly. Imported electricity via GJ1 has a very low carbon intensity factor of 5.7 gCO_2e/kWh compared to HFO's carbon intensity factors, which is 285 gCO_2e/kWh.

As shown in Figure 12, the total emission from electricity supply to the Island of Guernsey are expected to reduce by 93% due to the implementation of the Electricity Strategy[28]. The main drivers are the expected installation in 2030 of a second interconnector to France, GF1, the expected installation of an offshore windfarm in 2035, the accelerated uptake of solar PV generation and the expected switching to using renewable fuels from 2040, e.g. hydrogen.

The capital expenditure to implement the electricity strategy is £530m.

[28] States of Guernsey - Electricity Strategy

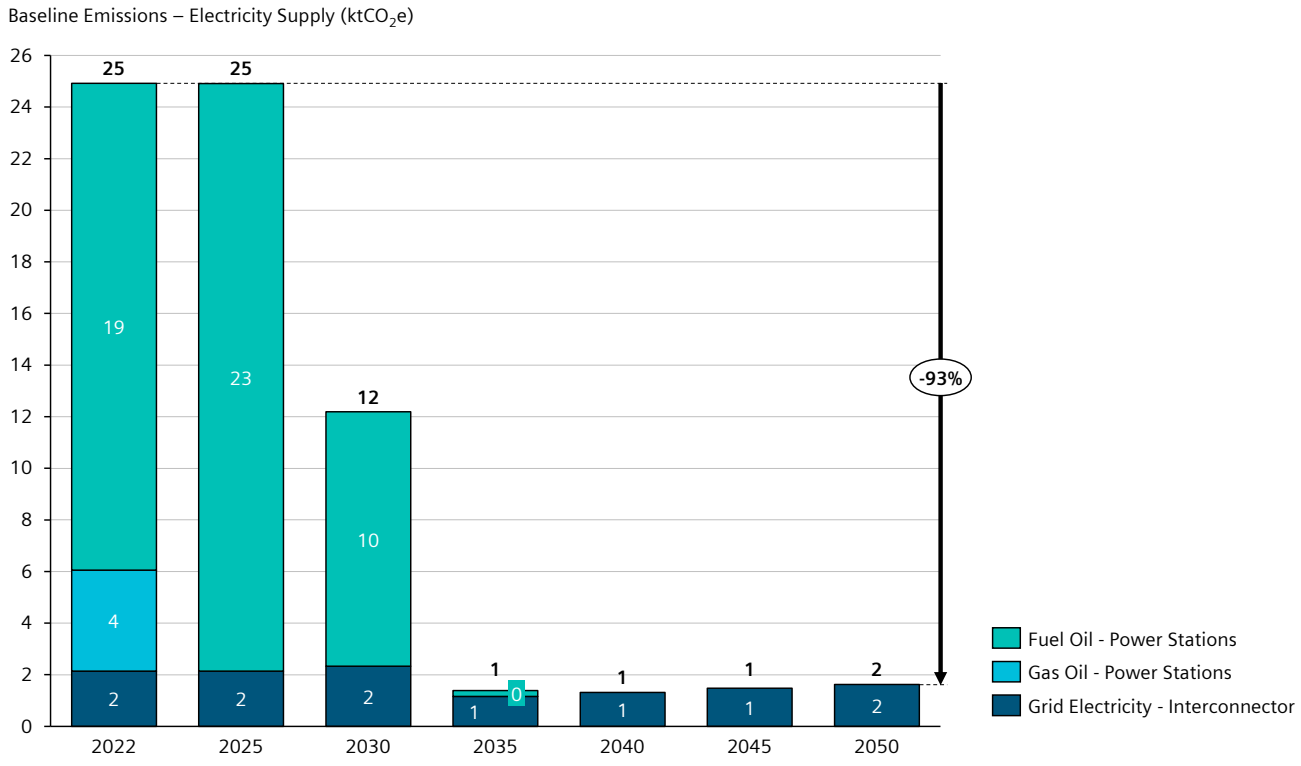


Figure 12: Baseline pathway emissions – Electricity Supply

3.5 F-gases

F-gases is the collective name for several greenhouse gases which contain fluorine. In 2022, the sole F-gases emitted were hydrofluorocarbons (HFCs) which are used in the business and residential sectors as key components of air conditioning and refrigeration units, fire extinguishers, and medical inhalers. At 13.8 $ktCO_2e$, F-gases contributed 5% to Guernsey's overall 2022 emissions. 12.9 $ktCO_2e$ are from the business sector, compared to 0.9 $ktCO_2e$ in the residential sector.

Guernsey imports goods using F-gases, largely from the UK and France. Therefore, the Baseline pathway reflects technology changes to these imported goods, driven by legislation. The European Union's (EU's) regulation on fluorinated greenhouse gases ((EU) No 517,2014[29]), more commonly known as the 'EU F-gas Regulation', was retained in UK legislation after the UK's exit from the EU. The F-gas Regulation includes measures to reduce use and emissions of F-gases by:

- Establishing rules on containment, use, recovery and destruction of F-gases
- Imposing conditions on the placing on the market of specific products and equipment containing F-gases
- Imposing conditions on the specific uses of f-gases
- Establishing quantitative limits for the placing on the market of HFCs

The F-gas Regulation also states that the quota of HFCs available on the market must steadily decrease to reach a 79% reduction between 2015 and 2030.

Guernsey is a signatory to the Montreal Protocol, which intends to control and phase out ozone depleting substances (ODS). In 2016, the Parties to the Montreal Protocol also decided to regulate an additional group of F-gases, hydrofluorocarbons (HFCs), known as the Kigali Agreement. Guernsey has not yet ratified the Kigali Agreement, although significant work was undertaken to demonstrate to the UK's Department for Environment, Food & Rural Affairs (DEFRA) how it could comply. Part of this workstream involved drafting legislation that would prohibit the importation of F-gases into Guernsey other than from the UK, which would align with the UK's F-gas regulation legislation. This workstream was deprioritised but the legislation exists and could be implemented subject to the relevant Committee processes.

The CCC has modelled the impact of the F gas Regulation on the UK's f-gas emissions as part of the Sixth Carbon Budget[30]. Presented in their 'Baseline pathway', the CCC estimate that the implementation of the F gas Regulation will result in a 70% reduction in f-gas emissions in the UK between 2022 and 2050. As Guernsey import goods from the UK the impact of the F

[29] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517
[30] https://www.theccc.org.uk/publication/sixth-carbon-budget/

gas Regulation will be reflected in Guernsey's emissions (not accounting for behaviour change). The CCC's projections are for total f-gases. As a more disaggregated breakdown was unavailable, the same CCC reductions were equally applied to f-gases in both business and residential sectors.

For the Baseline pathway, Figure 13 shows emissions relating to the use of F-gases, together with the current and forecasted level of emissions up to 2050.

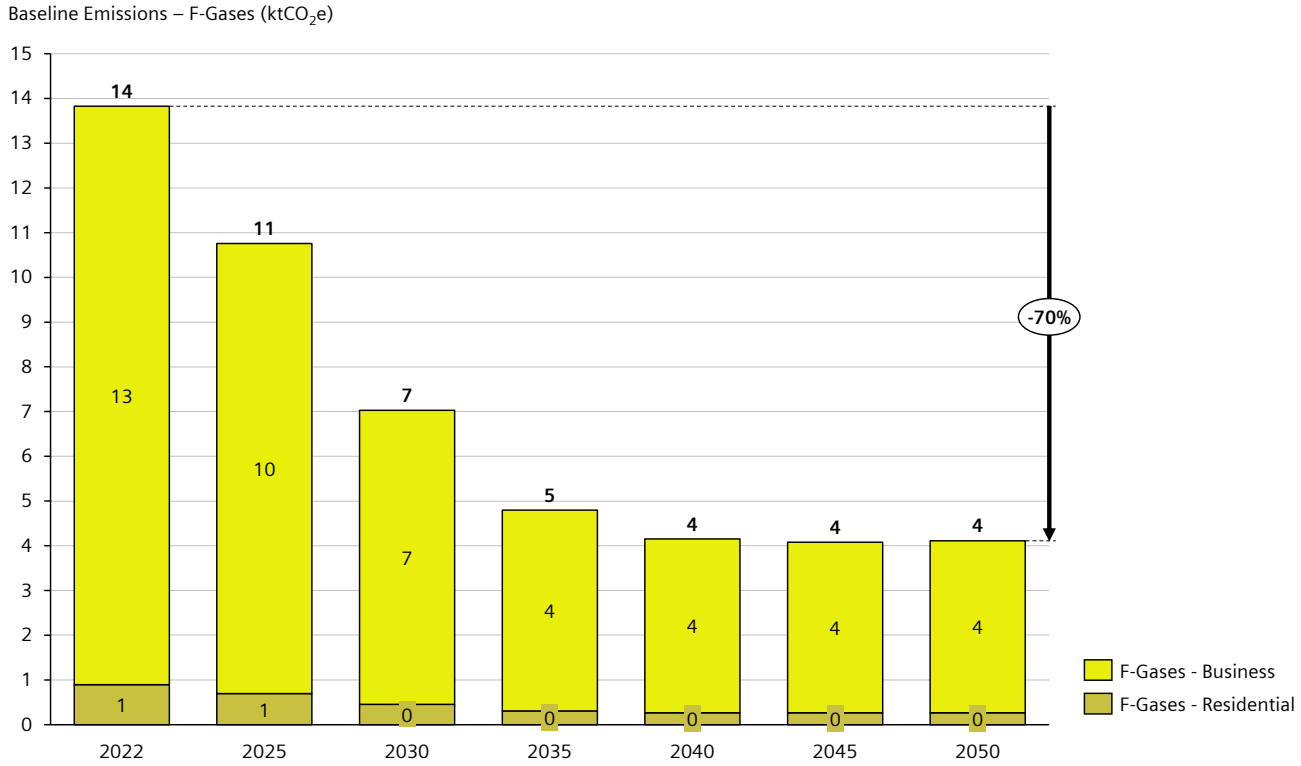


Figure 13: Baseline pathway emissions – F-gases

3.6 Land & Forestry

The Land & Forestry sector includes both emissions and removals from the use and management of land, and from the conversion of land from one land use type to another. In 2022, Guernsey's forestry and land use sector emitted 5.5 $ktCO_2e$ and sequestered 7.7 $ktCO_2e$, which resulted in a net sequestration of 2.2 $ktCO_2e$. Sequestration is shown by a negative emission value and means that overall, the sector is a sink for emissions, rather than a source. Woodland contributes to a net sequestration of carbon emissions, as does grassland, although to a lesser extent. Areas of cropland and settlements contribute to net emissions.

A Blue Carbon Report has been commissioned by the States of Guernsey and is expected in 2025. The aim of the report is to provide data and report on the natural environment to support better informed interventions, particularly in relation to possible benefits associated with planting seagrasses in Guernsey's coastal waters.

Land is limited in Guernsey and there are competing demands on available land. The Island Development Plan sets out land planning policies and has been considered in the preparation of the Baseline pathway, under which it is expected that land use will remain constant during the period 2022 – 2050. Therefore, emissions under the Baseline pathway are not projected to change.

For the Baseline pathway, Figure 14 shows the composition of emissions for the Land & Forestry sector, together with the current and forecasted level of emissions up to 2050.

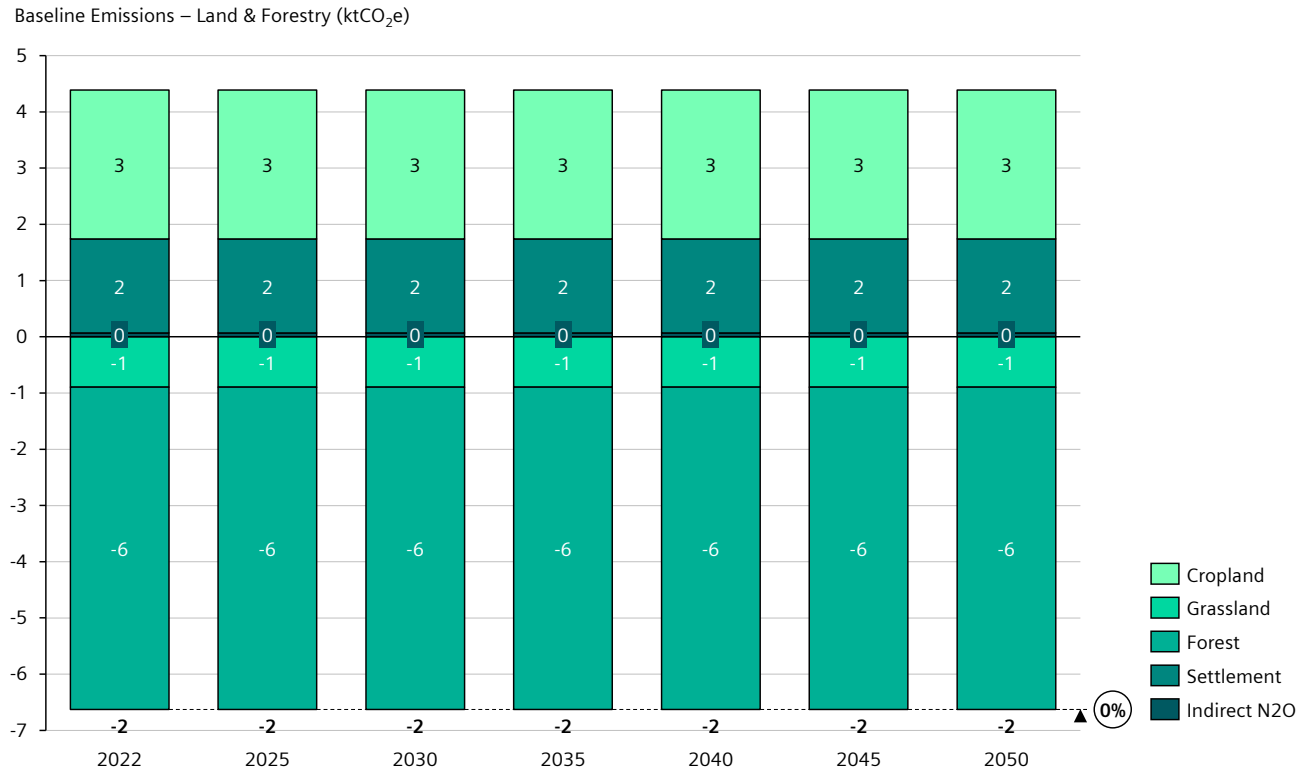


Figure 14: Baseline pathway emissions – Land & Forestry

3.7 Residential

As of 2022, there are 27,494 domestic buildings in Guernsey, which includes a mix of owned and rental properties, and the composition of Guernsey homes is predominantly made up of apartments, houses and bungalows[31]. Domestic combustion is the main CO_2e contributor, with gas oil, kerosene, and LPG used in domestic buildings for heating, cooking, and hot water purposes.

Guernsey's housing growth target considers a net migration of +300 people per year up to 2050, and anticipates adding 1,565 residential dwellings up to 2027[3233]. Whilst no targets are currently set beyond 2027, extrapolating housing growth up to 2050 could suggest the possibility of between 30.7k and 34.4k domestic buildings by 2050, which could represent a 12-25% increase compared to existing levels.

In addition to an assumed annual growth in residential buildings up to 2050, the Baseline pathway assumes that the average annual heating demand is 13.17 MWh per dwelling in line with IEA data[34] and that around 35% of residential buildings already use some form of electric heating. The adoption of e-heating systems and energy efficiency improvements, which includes direct electric heating, heat pumps and district heat networks as well as heat loss, operational and appliance efficiency measures, is in line with the Electricity Strategy[35], and which is expected to result in an 83% reduction in GHG emissions by 2050.

For the Baseline pathway, Figure 15 shows the composition of emissions for the Residential sector, together with the current and forecasted level of emissions up to 2050.

[31] States of Guernsey – Facts and Figures 2023
[32] States of Guernsey – The Guernsey Housing Plan
[33] Arc4 Limited – Guernsey Housing Market Review and Problem Identification
[34] Residential Heat Economics Calculator by IEA Residential Heat Economics Calculator – Data Tools - IEA
[35] States of Guernsey - Electricity Strategy

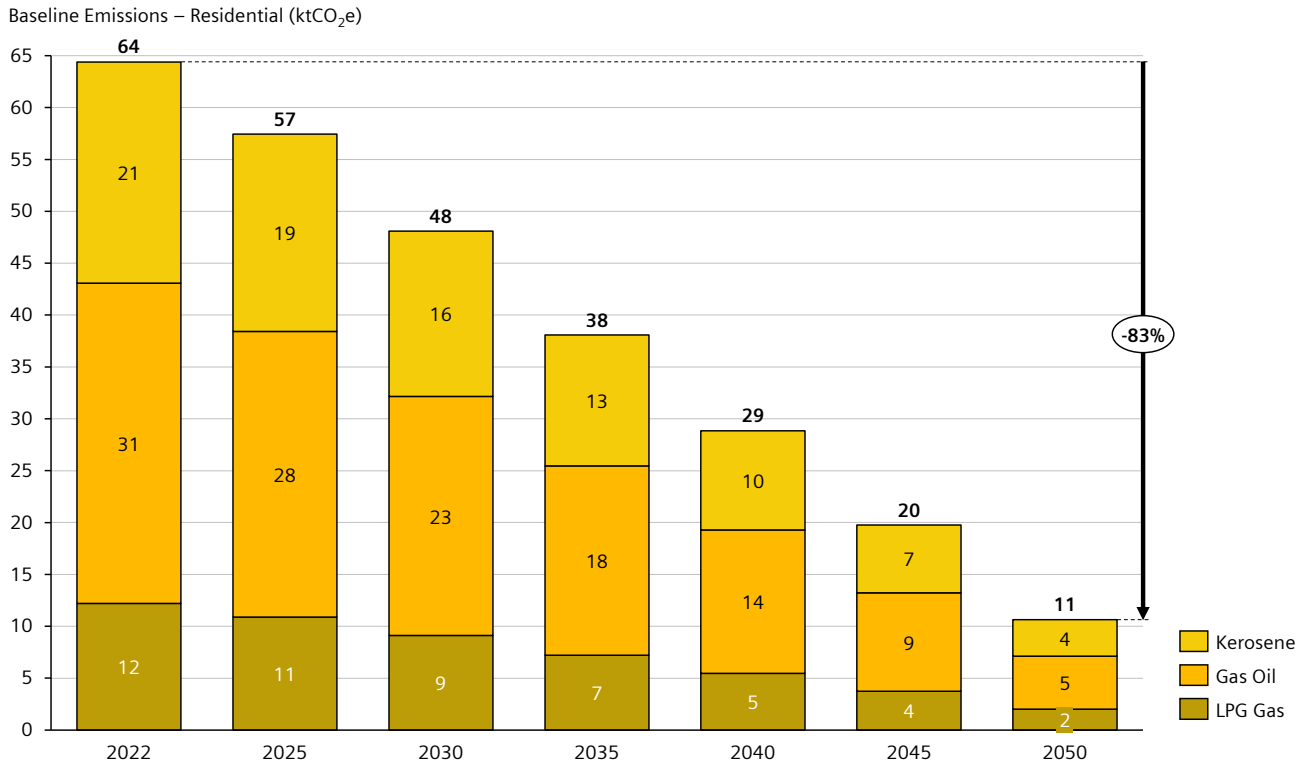


Figure 15: Baseline pathway emissions – Residential

3.8 Transport

In 2022, Guernsey's transport sector emitted 100 ktCO2e of emissions, comprised of road transport (66 ktCO2e), domestic aviation (20 ktCO2e) and domestic maritime / navigation (13 ktCO2e).

In the Baseline pathway:

- The effect of population growth increases on-Island travel demand, with the adoption of relative modal share and travel demand per person both set to a constant.
- Aviation and marine sector are assumed to be constant, with the effects of population and economic growth offset by a continued historical decline in aviation and maritime travel.
- The effect of economic growth increases the level of on-Island goods transport.
- Adoption of electric road vehicles occurs in line with the electricity strategy, supported by a ban on new ICE vehicles in 2035, and achieves an EV penetration of 95% and results in 94% emission reduction in 2050.

For the Baseline pathway, Figure 16 shows the composition of emissions for the Transport sector, together with the current and forecasted level of emissions up to 2050.

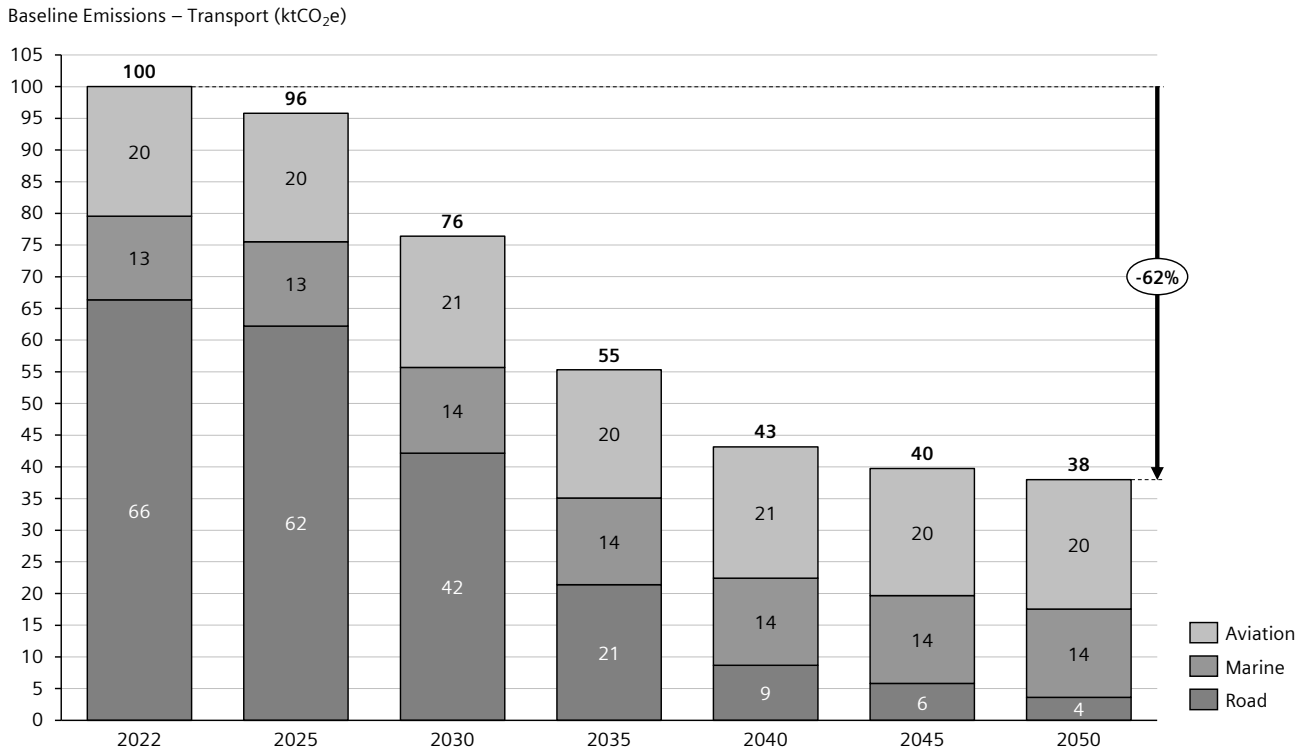


Figure 16: Baseline pathway emissions – Transport (Aviation, Marine, Road)

3.8.1 Aviation Transport

In 2022, Guernsey's domestic aviation emissions were 20.4 $ktCO_2e$. Emissions are allocated to the country of departure and are split in the inventory into Take-Off and Landing (TOL) and cruise. As stated in section 2.1, domestic aviation covers trips between Guernsey and the UK, Jersey, and Isle of Man.

Guernsey's aviation travel volumes have generally declined over past 20 years and this trend is expected to continue. This decline is linked to population levels and economic factors such as less business travel in connection with the financial services industry. However, whilst overall aviation travel volumes have declined, there is growing demand for new direct routes to be established, and it is now possible to travel direct to Dublin (popular for onward travel to USA), Spain (Palma, Majorca), France (Paris, Grenoble), Switzerland (Geneva). Additional direct routes to non-UK countries are anticipated, however it is challenging to predict these changes, together with level of impact on demand, up to 2050.

Whilst Guernsey's Government can influence the demand for aviation travel, changes in aircraft technology are largely dependent on market trends. Therefore, the projections developed as part of the UK's Jet Zero Strategy[36] were used to derive the Baseline, Moderate, and Ambitious pathways. Scenario 1 of the Jet Zero Strategy represents the continuation of current trends in the UK. This includes:

- 34% increase in air traffic movements
- 1.5% annual improvement in fuel efficiency
- Sustainable Aviation Fuel (SAF) use accounts for 10% of total fuel supply in 2050
- No zero-emission aircraft by 2050

These assumptions equate to a 0.1% reduction in UK aviation emissions between 2022 and 2050. It was assumed that the same rate of reduction would occur in Guernsey in the Baseline pathway as a high proportion of Guernsey's flights are to/from the UK and therefore the aircraft would align with the assumptions under UK Jet Zero.

The inventory provides historic aviation emissions split by fuel type. The above assumptions were applied to activity using aviation spirit and aviation turbine fuel. For activity using SAF, it was assumed that there would be no change as part of the Baseline pathway due to discussions during stakeholder interviews, where it was mentioned there was limited demand due to costs. This juxtaposes the assumptions behind the UK's Jet Zero Strategy; however, the published projections dataset is not detailed enough to disentangle the impact of fuel efficiency improvements vs SAF use.

[36] UK Jet Zero Strategy: Delivering Net Zero Aviation by 2050

3.8.2 Maritime Transport

Marine transport covers emissions from domestic shipping vessels such as passenger ferries, container and general cargo ships, service vessels, fishing vessels and leisure vessels. Guernsey's GHG inventory distinguishes between fishing vessels and all other vessels, with fishing vessels accounting for approximately 15% of emissions and all other vessels accounting for 85% of emissions. In terms of fuels used, all fishing vessels use gas oil, and all other vessels use gas oil (99%) and fuel oil (1%). Note that fuel oil is typically used by larger ships, suggesting that visiting ships re-fuel elsewhere.

As stated in section 2.1, domestic navigation covers trips between Guernsey and the UK, Jersey, and Isle of Man, and would include visiting cruise ships that arrive from the UK or Jersey. However, emissions associated any vessel that originates from other jurisdictions, such as France, are not included in the GHG inventory.

In 2022, emissions from marine transport were 13.2 $ktCO_2e$. In the inventory, these emissions are split into shipping – coastal (fuel oil, 0.06 $ktCO_2e$), coastal shipping (gas oil, 11 $ktCO_2e$), and fishing vessels (gas oil, 2 $ktCO_2e$). The Baseline pathway assumes that the fuel used for coastal shipping (covering activities such as cargo, ferry and service vessels, and only cruise ships that arrived from the UK) scales in line with projected population. This equates to a 6% increase in fuel use, and therefore emissions, by 2050. It is assumed there will be no change in fuel used for fishing vessels.

3.8.3 On-Island Travel

Road transport accounts for 22% of Guernsey's reported GHG Inventory emissions (66 $ktCO_2e$). Road transport emissions arise from the presence of passenger vehicles e.g., cars, mopeds and motorcycles (95%), light-duty vehicles (4%), and buses and heavy-duty vehicles (less than 1%). Although the numbers of mopeds and motorcycles are increasing, the overall contribution to road transport emissions is less than 1%. For cars, petrol accounts for 61% and diesel accounts for 34%, and 5% are electric.

Guernsey does not have specific models covering transport modes, number of trips, trip distance and trip purpose in Guernsey. Therefore, Guernsey's GHG inventory uses a distribution of emissions that aligns to the transport modes modelled based on the UK's urban, non-London areas[37]. Based on this, which assumes an average capacity utilisation of cars and buses with constant mileage over time, the modal share in Guernsey assumes approximately 95% for car travel, less than 1% for mopeds and motorcycles, and public transport and active travel accounting for the balance.

The States of Guernsey has set clear priorities on transport modes according to the Integrated Transport Strategy[38].

Active Travel: Walking & Cycling

Positive progress has been made in encouraging walking and cycling, and reducing car journeys, and progress is evident through periodic surveys:

- Surveys of people walking along Glategny Esplanade show a 25% increase during the morning commute.
- A survey of people cycling along Les Banques showed an increase of up to 50%.
- Surveys of people who purchased an e-bike under a subsidy scheme in 2018 indicated an estimated reduction of 100,000 car journeys per annum (equivalent to circa 250,000 fewer car miles per annum).

Overall, it is estimated that active travel accounts for 5% of travel based on passenger mileage travelled, representing an equivalent of 1km per person per day.

Despite progress made in reducing car journeys and miles, the level of reduction is estimated at only 0.1% of total car miles travelled.

In the Baseline pathway, no specific interventions and corresponding reduction in emissions are assumed for public transport.

Public Transport & School Travel

Based on discovery interviews with stakeholders, the bus network offers good reliability and average-good coverage. A fixed bus schedule offers frequency ranging between 30 minutes (at peak times) to 2 hours, which is not regular enough for some users, especially those travelling across the Island. Night buses (10pm to 12am) exist but are seen to compete with taxi services. Routes are mostly via St. Peter Port as a hub location, requiring changes. Additional bus routes are being considered, e.g. to the airport.

The States of Guernsey owns the fleet of approximately 44 buses, and outsources the running of the bus service to a third-party operator. The fleet is mostly low-emission diesel, and is considering the introduction of two (2) EV buses following a recent trial. Bus fares are subsidised, and fare increases will be implemented shortly.

St. Martins Primary School has introduced an effective travel plan which has greatly reduced the volume of traffic to, from and around the school.

In the Baseline pathway, no specific interventions and corresponding reduction in emissions are assumed for public transport.

[37] NAEI road fleet projections for the transport sector
[38] States of Guernsey – On-Island Integrated Transport Strategy

Individual Motorised Transport (IMT)

There are approximately 56,000 registered cars and vans in Guernsey, of which approximately 5% are PHEV or EV. A high level of vehicle ownership and of single occupied cars contributes to high levels of traffic and congestion levels.

However, the States of Guernsey's Integrated Transport Strategy (last reviewed in 2019) reported positive progress on traffic movements, levels of vehicle ownership and single-occupancy journeys, and highlighted:

- Average weekday traffic movements into St. Peter Port during the morning commute had reduced by 4.7%, representing 130 fewer motor vehicles entering Town between 08:00 and 09:00 each day.
- Average 24-hour weekday vehicle movements on key arterial routes into St. Peter Port had reduced by 1.6%, representing 842 movements per day.
- The number of cars registered annually in Guernsey had reduced by approximately 19%.
- Solo-occupancy vehicle journeys have reduced by around 5%.

Several initiatives relating to road vehicle ownership and usage have been considered and debated but not approved or implemented because of strong lobbying. Examples of considered initiatives include the introduction of paid parking, vehicle taxation and distance charges. Such proposals have been primarily driven by a need for income generation rather tackling emissions, and their implementation is still a possibility.

Whilst narrow lanes would prevent the introduction of dedicated cycling, car pool and bus lanes, and pose challenges for the introduction of autonomous vehicles, overcoming some of these challenges might still be achieved. For example, some of the wider one-way roads could allow for a cycling contraflow, created by a painted lane on the road, albeit a trial and legislative process is required to install these.

A ban on buying new ICE vehicles is currently aligned to the UK, which has recently been delayed by the previous UK Government from 2030 to 2035, and this is assumed in the Baseline pathway for Guernsey.

In the Baseline pathway, the adoption of Electric Vehicles (includes all cars and Light Goods Vehicles (LGVs), and all buses and Heavy Goods Vehicles (HGVs) later in the period) increases from 4% to 95% up to 2050.

3.9 Waste Management

In 2022, waste-related emissions totalled 41.75 $ktCO_2e$, equivalent to 13.9% of Guernsey's total reported GHG emissions in the inventory. Waste management emissions cover both solid waste and wastewater activities in Guernsey, with the largest source in 2022 attributed to the historical use of landfill (34.83 $ktCO_2e$), followed by sewage sludge decomposition (4.53 $ktCO_2e$), composting (1.99 $ktCO_2e$), and incineration of clinical waste (0.39 $ktCO_2e$).

Figure 17 shows the composition of waste emissions in 2022, and projected reduction in emissions up to 2050 attributed to the declining level of emissions from the historical use of landfill.

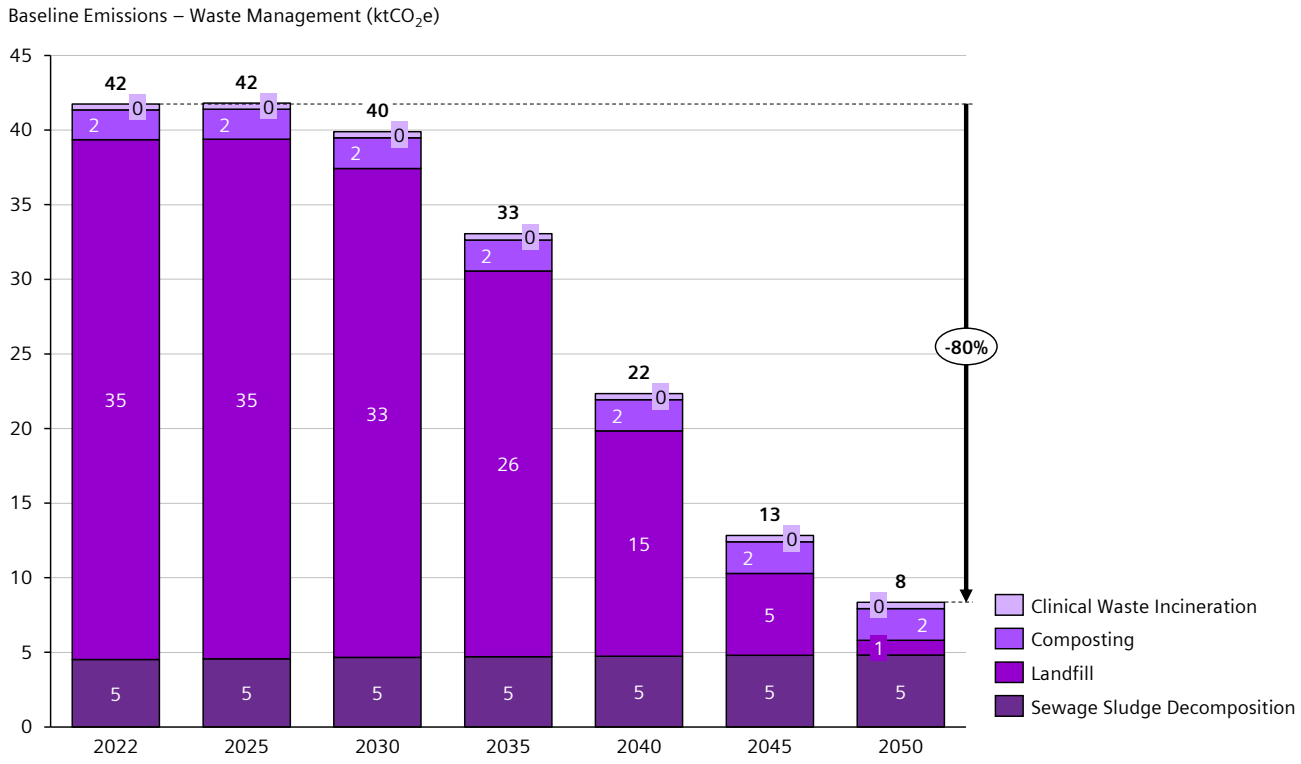


Figure 17: Baseline pathway emissions – Waste

Landfill

Considering the landfill related emissions, the baseline position of 34.83 ktCO2e/year has been derived by the application of the appropriate IPCC Waste-Landfill Protocol[39]. It is known from discussions with the States of Guernsey's Waste Department and review of the Waste Management Plan Report 2021 and 2022[40], that Guernsey's landfill site at Mont Cuet has seen a major reduction in materials being placed into it due to recycling, re-use and energy recovery of wastes since 2018.

Landfill rates have declined since 2018 as from Households at c10,700 tpa and Commercial at 11,300 tpa to a 2022 level of c250 tpa and 2,700 tpa respectively. Mont Cuet does still receive waste materials with no energy recovery potential or viable recycling route into landfill, however this is viewed as inert and not emitting greenhouse gases. Therefore, the landfill is viewed as in a closing period for major waste internment, and the natural decline in methane generation is assumed to have commenced in 2019.

This process of decline is viewed as following established 8 phases of a landfill "lifetime" as below which is principally driven by the evolution of a Landfill Gas (LFG). The composition of landfill gas changes as the waste decomposes. The 8 distinct phases are recognised and shown in Table 7.

[39] 2006 IPCC Guidelines, Volume 5 Waste
[40] Statues of Guernsey – Annual Waste Management Report

Table 7: Landfill decomposition phases

	Decomposition Phase	Activity / Drivers
1	Aerobic	Follows waste deposition in which the residual oxygen is used up. This phase typically lasts for a few days to months, depending on local factors such as temperature and moisture availability.
2	Acid	Populations of facultative and fermentative anaerobic bacteria develop and produce volatile fatty (aliphatic) acids, CO_2 and H2, and displaces the remaining N2 entrained with the waste. May last for weeks to years, depending on conditions.
3	Initial Methanogenic	Microbial respiration reduces oxygen concentrations to extremely low values, allowing populations of methanogenic bacteria to develop, producing CH_4. Concentrations of H2 and CO_2 start to fall.
4	Stable Methanogenic	The remaining H2 is used up in the reduction of CO_2 to CH_4 and H2O. May begin within months to years after waste deposition and last for decades. Landfill sites which collect gas for energy recovery are often designed around an assumed lifetime of 10 – 15 years of phase IV. Typical landfill gas collected in this phase consists of 40 – 65 % by volume of CH_4, with most of the balance made up by CO_2. A vast range of trace components are also present (such as volatile fatty acids, reduced sulphur compounds etc.) plus water vapour at saturation point. These substances usually make up only 1 or 2 % of the landfill gas, but account for its characteristic sweetish smell.
5	Air Intrusion	The rate of methanogenic activity begins to fall as substrate is used up, resulting in air beginning to enter the waste. Lower rates of gas formation lead to relatively faster washout of CO_2, so that its concentration falls relative to that of CH_4.
6	Methane Oxidation	Rates of methanogenesis have now fallen to low levels, allowing the rate of air ingress to increase, so that the surface layers of the waste and the capping material now become aerobic. Methane migrating through these layers is increasingly oxidised to CO_2 by methanotrophic bacteria. Methane concentration in the gas decreases, whilst that of CO_2 steadily increases.
7	CO_2	CO_2 phase. Return of aerobic conditions. By now the rate of landfill gas formation has virtually ceased because of substrate limitation and anaerobic decomposition becomes inhibited by the ingress of O2 in the air. This allows the aerobic decomposition of solid organic matter resistant to anaerobic decomposition.
8	Soil Air	Soil air phase. The final phase occurs when degradable organic matter has been oxidised and the landfill gas resembles that of typical soil air.

The duration of each of these decomposition phases is highly variable. Apart from the initial aerobic decomposition, which may complete in days to months, the remaining phases have durations measured in years, or even decades for the final phases. The present operational Mont Cuet and older closed Creve Coeur and Bordeaux landfills have a gas collection well system and flaring system in place, and the baseline level of emission tonnage as 34.83 ktCO_2e/year.

Based on information supplied by the States of Guernsey's Waste team, it is understood that the bulk of the landfill with closed cells is now in Phases 6 to 8, with only the last utilised cells in Phases 3 to 5, and with the present open cell taking minimal and little organic waste in Phase 1 to 2 only. Therefore, with the bulk of the landfill well past its main gassing stages, the profile from the baseline starting-point will see a declining gas evolution accelerating from 2030 up to 2050, with approximately 1 ktCO_2e of emissions by that time.

With the landfill viewed as being past its main CH_4 gassing point, the economic justification for engineering in a LFG collection system with CHP generation is weak due to the following factors:

- CH4 levels are at their peak and will decline, which is evident now with the Mon Cuet landfill at 34.3% composition and the older Creve Couer landfill at 30.3% composition - these levels being lower than the accepted operational range for use in direct combustion systems.
- The higher-than-normal level of H2S will be problematic in direct combustion systems, which will cause premature wear issues unless removed from the gas prior to use, and which would be costly.
- The high levels of N2 due to the low CH4 levels is also a cause of premature wear issues for direct combustion systems leading to nitriding of engine and blade surfaces.

However, with a newly installed transformer set, consideration could be re-visited, and such a power generation study can be extended to include an indirect combustion power generation system as offered by an Organic Rankine Cycle (ORC) system, which could be integrated directly into the flare system. Whilst this will not reduce the emission level, as flaring is still present, a level of power generation could be supplied to the local transformer set. For such a power generation study, the evolved CH4 / LFG gas volume as m^3/year to flare would be required.

At Mont Cuet landfill, the concentration levels of H2S present in the gas emission mix (~524ppm) is higher than seen in typical UK mainland landfill operation, and it is understood that this is due to a chemical reaction from the ingress of sea water into some of the cells from underlying geotechnical issues. H_2S can be viewed as having a neutral climate change effect at this time as the gas is not viewed as having a Global Warming Potential (GWP), as from IPCC Landfill Emission Protocols, however it is corrosive to metals and is hazardous. In regard to power generation systems, the present high levels of H2S (>500ppm)

would create acidification that accelerates the degradation of engine lubricating oils and causes hydrogen embrittlement of bearing surfaces, leading to premature engine failure.

Composting

Emissions from composting account for 1.9953 ktCO_2e/year of Guernsey's total reported emissions, and arise from the States of Guernsey's operated sites or on farms through a natural process. Farm composting will involve aerobic decomposition that arises from seasonal waste crop silage cutting, which is left to field, thus reintroducing natural nutrients back to the soil. At-home composting takes place on Guernsey and is supported and encouraged by the authority – home composting units are distributed enabling closed cycle at home reuse of garden wastes.

For households and commercial concerns who have green waste not suitable for home composting or for processing at the waste transfer station at Longue Hougue, provision is made at the Mont Cuet landfill site for the acceptance such green wastes, where material is processed into a soil conditioner. This is offered to members of the public to collect and use as a soil conditioner. At Mont Cuet, a windrow approach consisting of the following stages is in operation:

- Organic feedstock is shredded, mixed and placed into "windrows" / furrowed piles along a permeable surface, which connects with a basal leachate collection system and leachate treatment plant at the site, and treated leachate is discharged to sea in accordance with the conditions of the Waste Management Licence for the site.
- The windrows or furrowed piles are turned on a regular basis to improve Oxygen exposure and content, distribute heat to regulate temperature and to distribute moisture. The windrows are turned multiple times during the composting process, which can take up to sixteen weeks depending on seasonality and ambient conditions.
- Compost material is screened to remove any contaminants (plastics/metals) and to grade the compost for various end uses. Any oversized materials are returned via the shredder back into the process for further decomposition activity.

During all stages, emissions are vented freely to atmosphere. Whilst enclosed composting technology is available to capture emissions, this is considered uneconomic for Guernsey. Also, the resulting soil conditioner is valuable and is a balancing positive to the emission.

Clinical Waste

Emissions from clinical waste incineration account for 0.39 ktCO_2e/year of Guernsey's total reported emissions, and arise from permitted sites in Guernsey, which include surgeries, health care units and a Pathology Laboratory based at the Princess Elizabeth Hospital complex.

To safeguard the health and safety of patients and employees, regulation requires clinical waste to be segregated from normal waste streams and have its own intrinsic waste disposal route. It is typical for the clinical waste to be processed in small self-contained units, and units will have filtration systems to capture combustion toxins and particulates. However, these units do not currently capture CO_2/CO/N_2O components, which are emitted to atmosphere via an exhaust stack.

In Guernsey, a new clinical waste incinerator is under construction and due for commissioning in 2025. The new incinerator will combine inputs from the existing clinical waste incinerator and the existing animal carcass incinerator at the site of the current animal carcass incinerator at Longue Hougue, with the existing building being extended to accommodate the larger incinerator and additional clinical waste stream.

Sewage Sludge

Emissions from sewage sludge decomposition account for 4.53 ktCO_2e/year of Guernsey's total reported emissions, and is calculated in accordance with the IPCC Protocol Chapter 5 Waste – section 5.2 Emissions from Wastewater Handling. In the protocol, it is viewed that developed jurisdictions treat their wastewater with aerobic treatment facilities, lagoons, and settlement ponds.

Guernsey operates a common single system that co-mixes storm and run off waters with sewage effluent, which processes an average 12.5m litres of wastewater each day, subject to seasonality fluctuations, giving some 4.563×10^9 Litres of wastewater per year, which is approximately 4.5M to 5M tonnes of wastewater per year.

Guernsey at present does not operate any biological wastewater treatment so has little to no intermediate storage and uses a straight to ocean discharge approach. This discharge passes through the Belle Greve Wastewater Centre (BGWwC) to the Belle Greve Outfalls, this outlet handles 99% of all foul flows from the Island. In 2015, a new discharge piping system was completed allowing direct discharge further out to sea into the Little Russel area of the east coast of Guernsey. The seas around Guernsey generate a 10m tidal range and a 6-knot flow rate with the Little Russel discharge outflow being perpendicular to these flows accelerating solids breakdown and dispersion. The new 2015 discharge system consisted of solid wall HDPE outfall pipe(s) for wastewater and storm flows running for 2.4km offshore out to a dept of 30m below mean low water into the Little Russel, and improved discharge area over the old discharge area.

Guernsey Water is operating under its current Business Plan, which runs from 2016 to 2025, and this has no stipulation for any further major investment developments to alter the present approach to wastewater management. Therefore, the Baseline

pathway continues to apply emissions as from the IPCC Protocol, and additionally considers additional emissions due to an expected population increase up to 2050.

Note that the level of emissions reported in the GHG inventory, and therefore the Baseline pathway, is based on a level of aerobic stabilisation and treatment in a conventional open air water treatment plant, which is not present in Guernsey. Therefore, whilst the emission is present, the actual emissive activity is unknown because it occurs in the sea, and there is no IPCC Protocol for this direct-to-sea approach, and which may result in a much-reduced CO_2 and CH_4 level. Therefore, the IPCC Protocol is applied to the developed pathways as though Guernsey was to operate aerobic stabilisation and treatment in a conventional open air water treatment plant, and this is consistent with the level of emissions reported in Guernsey's GHG inventory.

3.10 Guernsey's Impact on Emissions outside of its Jurisdiction

In this section, Guernsey's impact on Scope 3 emissions is estimated in connection with its prevailing policy to export food and solid waste to other jurisdictions, and in respect to visiting cruise ships.

3.10.1 Exported Waste

In 2022, Guernsey's exported waste consisted of 4,882 tonnes of food waste and 11,324 tonnes of Refuse Derived Fuel (RDF), with 66.8% originating from households and 33.2% originating from commercial sources. Food waste is exported to the UK for Anaerobic Digestion (AD) treatment in the UK, and RDF waste is exported via the UK to Scandinavia where it is used to generate electricity in an Energy Recovery Facility (ERF). Additionally, Guernsey's Waste Management 2022 report indicates that a privately operated transfer station produces and exports 6,461 tonnes of Solid Recovered Fuels (SRF) and 4,282 tonnes of Biomass material, which is classified as commercial waste.

Within Guernsey's GHG inventory, emissions are reported in connection with collecting and transporting food and solid waste via Guernsey's roads (Transport Sector, Road Vehicles) and transporting it to the UK (Transport Sector, Domestic Navigation), and additionally fuels used at local waste processing facilities at Longue Hougue (Business Sector, Combustion).

From the point that all exported waste reaches the UK, emissions associated with subsequent transportation and processing are expressly excluded from Guernsey's emissions, and is therefore not reported in Guernsey's GHG inventory and excluded from the Baseline pathway. To estimate emissions outside of Guernsey's jurisdiction for exported food waste and RDF material, WRATE (a UK Environmental Agency software modelling approach) is used, which aligns with and follows Climate Change Plan (CCP) protocols.

Organic Food Waste

Organic food waste under the States of Guernsey's control is gathered at Longue Houge and transported as a liquid slurry by tanker via ferry to Portsmouth. It is then transported by road to the Biogen UK Anaerobic Digestion plant at Basingstoke, where it is mixed with other incoming wastes and processed in a digestor to produce a biogas for use in CHP engine sets. This journey is shown in Figure 18, and uses WRATE analysis to estimate emissions at each stage of the journey.

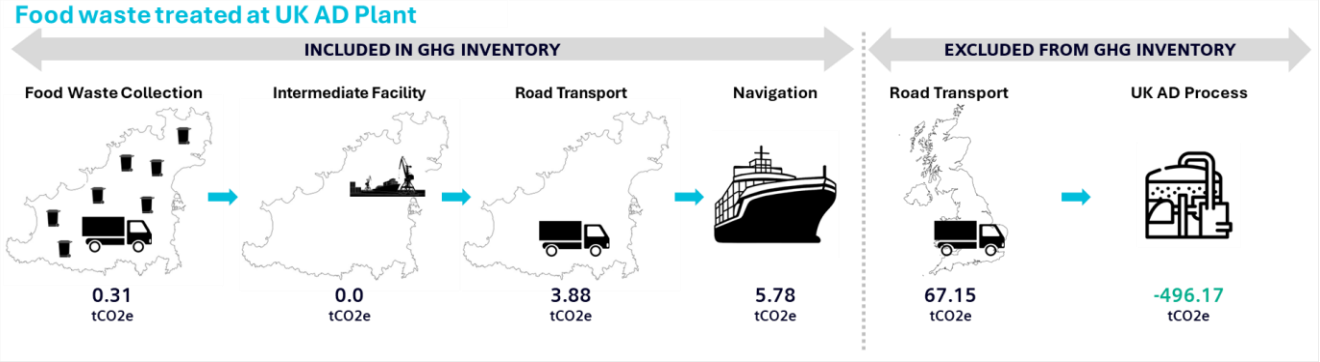


Figure 18: Guernsey's exported food waste journey and emissions at each stage of the journey

Included in Guernsey's GHG inventory are emissions associated with collecting and processing organic food waste in Guernsey, and shipping it to the UK. However, emissions associated with the transporting food waste in the UK is not included.

Based on Guernsey's current policy of exporting food waste, 72.93 tCO_2e/year of transport-related emissions are generated that might otherwise not exist, comprised of 5.78 tCO_2e/year within the inventory and 67.15 tCO_2e/year outside of the inventory. However, these emissions are relatively small and significantly lower than the recurring and accumulating emissions that would result from using local landfill.

Refuse Derived Fuel Material

RDF material under the States of Guernsey's control is contracted for energy recovery at several ERF (Energy Recovery Facilities) plants in Sweden, with material shipped to Southampton and transported by road HGV to Tilbury before it is then shipped to

southern Sweden and transported by road HGV to the end point of use. This journey is shown in Figure 19, and uses WRATE analysis to estimate emissions at each stage of the journey.

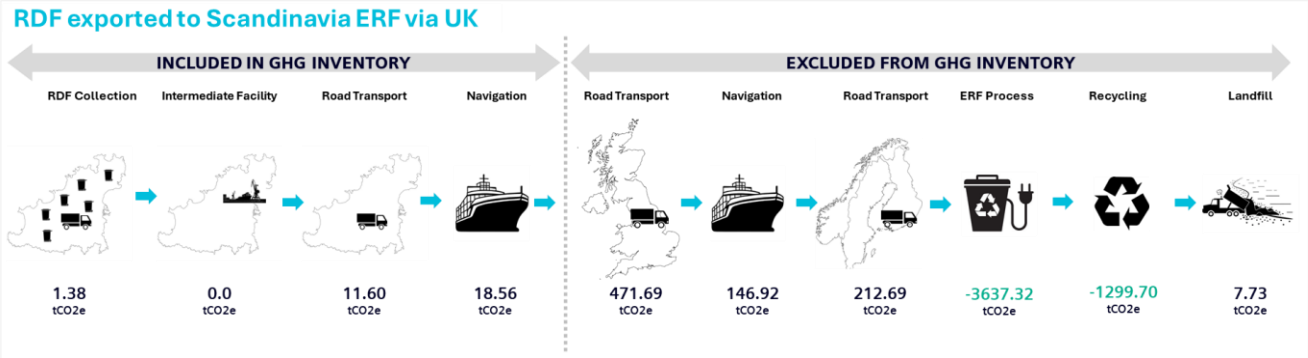


Figure 19: Guernsey's exported RDF material journey and emissions at each stage of the journey

Based on Guernsey's current policy of exporting RDF material, 849.86 tCO_2e/year of transport-related emissions are generated that might otherwise not exist, comprised of 18.56 tCO_2e/year within the inventory and 831.3 tCO_2e/year outside of the inventory. Additionally, 7.7 tCO_2e/year of external emissions result from the residual hazardous waste that is created by the energy recovery process and goes to landfill in Sweden. Note that the landfill emissions in Sweden are lower than the recurring and accumulating emissions that would result from adding collected waste to Guernsey's local landfill, which would emit between 1.5 and 2.0 times the level of emissions.

3.10.2 International Navigation - Visiting Cruise Ships

In line with the approach outlined in section 2.1, cruise ships that travel between Guernsey and the UK and other Crown Dependencies (Jersey and Isle of Man) are considered as 'domestic' and are therefore included in Guernsey's inventory. Emissions are allocated to the place of arrival. Cruise ships that travel between Guernsey and other locations are considered 'international' and are excluded from Guernsey's GHG inventory. The tender boats used to transport passengers to shore, and the emissions caused by activities of visitors whilst on the Island, are included in the relevant sectors of the GHG inventory. Scope 3 emissions from cruise ships have been considered as part of this project due to their potential environmental impact beyond Guernsey's boundaries. A study by Friends of the Earth predicted that the emissions from single day of travel on a cruise ship could be 8 times higher than a single day of travel on land[41].

Cruise ship emissions were calculated by estimating emissions from four cruise ships and scaling those emissions to the 76 cruise ships which visited in 2022. Four cruise ships were selected using Guernsey's cruise ship visit list[42] from 2024: Le Lyrial (200 passengers), Silver Spirit (648 passengers), Ambition (1904 passengers) and Borealis (1685 passengers). For each of these four ships, emissions were calculated in the following manner:

- Gross tonnage and engine power obtained from Kpler's MarineTraffic tool[43]
- Time spent in Guernsey's waters travelling between Guernsey and international countries e.g. France estimated via live tracking from Kpler's MarineTraffic tool[31]. As only time spent in Guernsey's waters were considered, please note this approach differs from the inventory definition of international travel, where the emissions for the whole of a direct route are allocated to the place of arrival.
- Time spent manoeuvring estimated using defaults in the 2023 EMEP/EEA Guidebook[44]
- Internationally-recognised standard load factor taken from 2023 EMEP/EEA Guidebook
- Internationally-recognised standard factors on grams of fuel used per kWh engine power taken from 2023 EMEP/EEA Guidebook
- Internationally-recognised standard GHG emission factors taken from 2006 IPCC Guidelines

As various default factors were used to derive an estimate, the final emissions estimates should be considered with high uncertainty. Out of the above factors, the engine power of the vessel, time at sea, and fuel type are the most impactful factors in terms of estimating GHG emissions.

[41] https://foe.org/wp-content/uploads/2023/04/Comparison_of_CO2_Emissions_v2.pdf
[42] Guernsey cruise ship visits 2024
[43] https://www.marinetraffic.com/en/ais/home/centerx:-2.5/centery:49.4/zoom:9
[44] The EMEP/EEA Guidebook is an international guidance document used to calculate national air pollutant emissions inventories. This Guidebook provides more detail on assumptions than the IPCC Guidelines used to estimate GHG emissions: https://www.eea.europa.eu/publications/emep-eea-guidebook-2023/part-b-sectoral-guidance-chapters/1-energy/1-a-combustion/1-a-3-d-navigation/view

The average emissions of the four vessels equated to 80 tCO_2e per vessel and per visit, which scaled up to 76 vessels is equal to 6 $ktCO_2e$. However, the emissions from Borealis were approximately 10 times larger than the other vessels. If the average characteristics of all cruise ships visiting Guernsey such as size, age, and efficiency are similar to Le Lyrial, Silver Spirit, and Ambition, then the annual emissions total is significantly reduced to 1 $ktCO_2e$. The large emissions from Borealis are driven by significantly larger engine power compared to other reviewed vessels and longer time spent in Guernsey's waters. However, as highlighted the use of multiple default factors means that there is significant uncertainty with the emissions estimates calculated. The derived figures should therefore be treated as indicative and provide an approximate range compared to Guernsey's scope 1 emissions.

DECARBONISATION PATHWAY OPTIONS FOR THE ISLAND OF GUERNSEY

4.0 Moderate and Ambitious Pathways for the Island of Guernsey

The Baseline pathway suggests that Guernsey could achieve a 57% reduction in emissions by 2030 compared to the levels recorded in 1990. Moderate and Ambitious pathways aim to achieve Guernsey's agreed carbon reduction and net zero targets, and additionally considers options to support an increased level of ambition. All pathways work towards achieving net zero emissions, however they do not result in net zero emissions, and will depend on future technological advancement.

The Moderate Pathway considers interventions that are established, mature and common practice in other jurisdictions, whilst being suitable for Guernsey. This pathway aimed to demonstrate net zero Scope 1 and 2 GHG emissions by 2050, whilst meeting the 57% reduction by 2030 interim Climate Change Policy target.

The Ambitious Pathway aims to push the boundaries of the interventions in the Moderate pathway in terms of scale, penetration and performance, whilst considering additional interventions that may be considered less-proven or more 'cutting-edge' in their field. This pathway sought to explore the potential for advancing net zero Scope 1 and 2 GHG emissions ahead of the 2050 target, and demonstrate the ability to increase interim emission reductions.

For the Moderate and Ambitious pathways, the most significant undertaking will be rapidly reducing the use of conventional fuels across all sectors, and key to achieving this lies in electrification, which additionally necessitates the decarbonisation of Guernsey's electricity supply. However, electrification is not the only answer. Reducing energy demand, improving energy efficiency and increasing the availability and adoption of renewable fuels can play a positive role in reducing emissions and working towards achieving net zero.

The interventions outlined in sections 4.1 (Moderate pathway) and 4.2 (Ambitious pathway) are each described in further detail in section 5, and any interventions that have been excluded are listed in Appendix A: Excluded Interventions.

4.1 Moderate Pathway

In comparison to the Baseline pathway that produces 101 $ktCO_2e$ of emissions in 2050, the level of emissions in a Moderate pathway could be reduced to 27 $ktCO_2e$ in 2050, a 74 $ktCO_2e$ reduction. A number of interventions across the sectors have been considered and modelled in the Moderate pathway to accelerate Guernsey's decarbonisation, with the positive impact in each sector summarised below:

- The Business sector can achieve an additional 27 $ktCO_2e$ reduction in GHG emissions up to 2050 by electrifying more heating systems, and electrifying processes or switching them to using alternative fuels.
- The Transport sector can achieve an additional 27 $ktCO_2e$ reduction in GHG emissions up to 2050 by switching marine vessels to using low-carbon fuels and replacing vessels with electric-powered alternatives, increasing the use of Sustainable Aviation Fuel, improving the public transport offering, and introducing bike and car sharing schemes.
- The Residential sector can achieve an additional 11 $ktCO_2e$ reduction in GHG emissions up to 2050 by strengthening building standards and using renewable fuels from 2035 onwards to power the remaining combustion type heating systems.
- The Agriculture sector can achieve an additional 5 $ktCO_2e$ reduction in GHG emissions up to 2050 by applying a range of interventions to farms, such tailoring livestock diets and improving slurry management, improving soil nutrition.
- The F-gases sector can achieve an additional 3 $ktCO_2e$ reduction in emissions up to 2050 by replacing ageing refrigeration systems to those with lower GWP coolants.
- Across all sectors, using only renewable fuels from 2050 onwards.

In the Moderate pathway, the Electricity Supply and Waste Management sectors do not reduce GHG emissions any faster or further than in the Baseline pathway. This is because the full implementation of Guernsey's electricity strategy is assumed in both pathways, and an intervention to locally produce renewable fuel from organic waste would have the effect of increasing and offsetting emissions in the GHG inventory.

Overall, the Moderate pathway can achieve a 91% reduction in GHG emissions by 2050 compared to 2022 levels, as shown in Figure 20, with a total of 27 $ktCO_2e$ of GHG emissions shown in 2050.

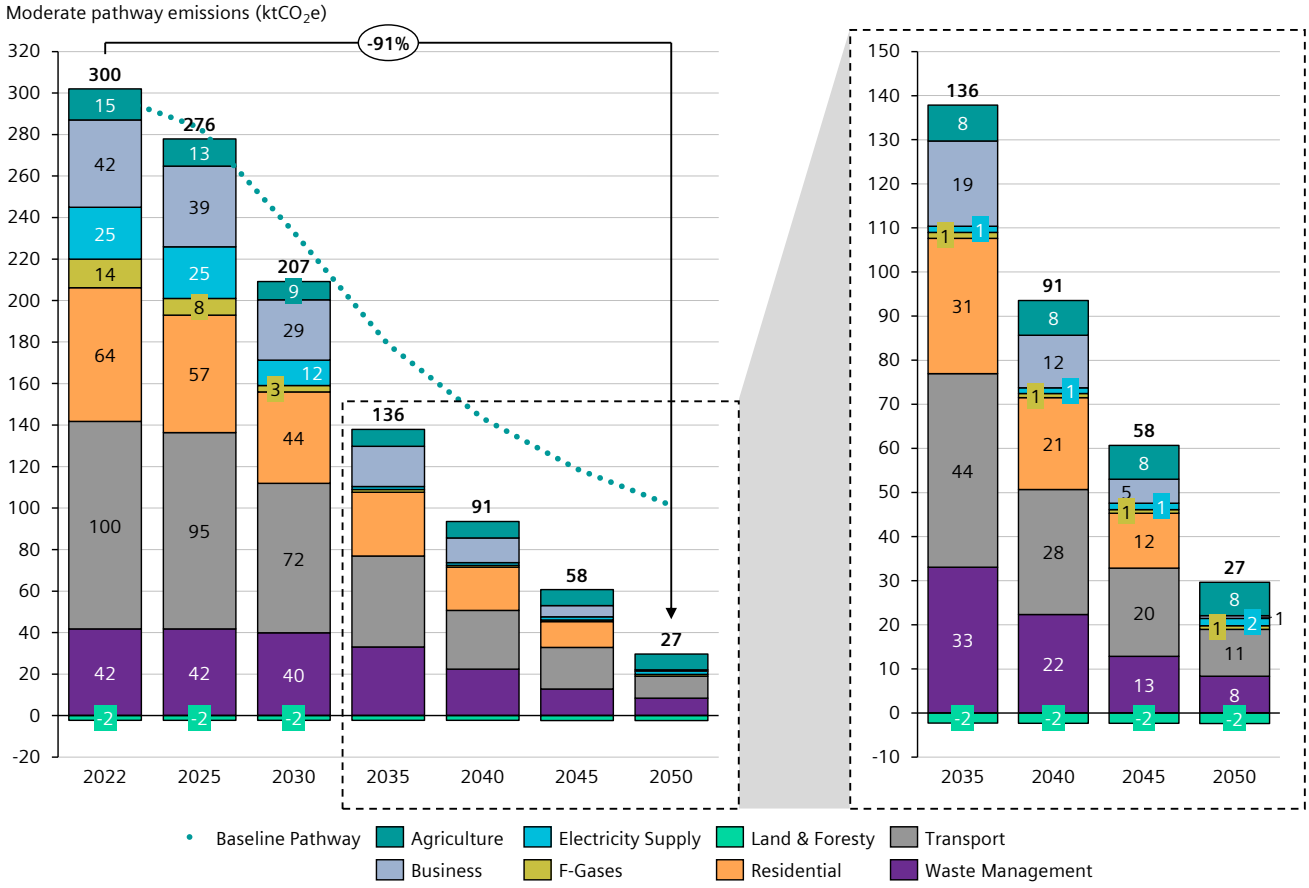


Figure 20: Moderate pathway

The additional investment required for the Moderate pathway up to 2050 compared to the Baseline is estimated to be in the region of £493m, as shown in Table 8 with a breakdown by sector. Note that 91% of the investment relates to the electrification of commercial and industrial heating and process in the Business sector, and implementation of the active and shared transport assets (e.g., bikes, vehicles) and infrastructure (e.g., cycle lanes, charging stations for vehicles and vessels) in the Transport sector.

Table 8: Additional investment in the Moderate pathway by sector compared to the Baseline pathway

Sector	Additional Investment compared to Baseline (£m)	Additional Emission Reduction by 2050 compared to Baseline ($ktCO_2e$/year)
Agriculture	7	5.3
Business (Including Industrial Processes)	293	27.3
Electricity Supply	-	-
F-gases	2	3.3
Land & Forestry	-	-
Residential	26	10.6
Transport (Aviation)	-	9.8
Transport (Maritime)	46	13.9
Transport (On-Island Travel)	109	3.6
Waste Management	10	-
Total	**493**	**73.8**

A direct comparison of indicative investment required up to 2050 to achieve the Baseline, Moderate and Ambitious pathways is additionally shown in Table 10, which includes a breakdown by decarbonisation theme and intervention, together with possible sources of investment, and benefits that include carbon savings, energy savings and GVA for Guernsey's economy.

Further detail of the interventions, together with timelines, expenditures and positive impact on reducing GHG emissions in the Moderate pathway, is set out below for each sector (refer also to Section 5 of this report that sets out the interventions in full detail). Consideration for policy development, together with incentives and disincentives, is also outlined below for each sector (refer to Table 12 for a summarised version).

Agriculture

In the Baseline pathway, GHG emissions in the Agriculture sector reduce from 15 $ktCO_2e$ to 13 $ktCO_2e$ up to 2050, a 2 $ktCO_2e$ reduction over the period.

In the Moderate pathway, an additional 5 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by applying a range of interventions to farms, such tailoring livestock diets and improving slurry management and soil nutrition:

- With Guernsey's dairy cattle accounting for more than 70% of the GHG emissions in the Agriculture sector, as described in section 3.2, an intervention is proposed to change the behaviour and practices of livestock farms and dairy production. This would involve changing ruminant nutrition, by introducing enzyme inhibitors and higher fat diets, and improving slurry management up to 2040. When taken together with an anticipated reduction in the consumption of dairy products as result of consumers gradually switching to alternative products, and requiring smaller herds, the changes can reduce GHG emissions by 4 $ktCO_2e$ compared to the Baseline pathway. This intervention would require an investment of ~£6m up to 2040.
- A further 1 $ktCO_2e$ of annual GHG emissions can be prevented by effectively addressing soil management, including the controlled release of fertilisers, rotating the growth of legumes and reducing soil compaction, amongst others. Implementing these sets of measures would require an investment of ~£330k up to 2040.

For the Agriculture sector, encouraging these changes would require the States of Guernsey to develop policies that communicate a clear direction to farmers regarding the nature of feeds and fertilizers that should (or shouldn't) be used, including their application, and levels of animal welfare to be achieved. The States of Guernsey could also help farmers to identify and report their emissions.

To encourage the implementation and adoption of new farming practices and discourage existing practices, a coordinated set of incentives and disincentives could be introduced. For example, this might involve the offer of grants that remove the price differential between electric farm equipment and conventional alternatives, the offer of subsidies to support the adoption of regenerative farming techniques to capture emissions in soil, and phasing in a carbon tax per head of livestock to encourage improvements in production yields.

Business (including industrial processes)

In the Baseline pathway, GHG emissions in the Business sector reduce from 42 $ktCO_2e$ to 28 $ktCO_2e$ up to 2050, a 14 $ktCO_2e$ reduction over the period.

In the Moderate pathway, an additional 27 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by applying a range of interventions to improve the fabric and energy efficiency of buildings, electrify heating systems, and switch to using renewable fuels:

- With the consumption of kerosene and gas oil responsible for 99% of the Business sector emissions in the Baseline pathway, as described in section 3.3, an intervention is proposed to retrofit 95% of commercial and industrial buildings with passive energy efficiency measures (e.g., insulation, airtightness, ventilation and solar shading) and active energy efficiency measures (e.g., building systems with smart controls and waste heat recovery etc.) would reduce the associated energy demand by 40% up to 2050. These measures range from insulating buildings to reduce heating demand, to introducing automation systems that efficiently management HVAC systems, and other processes.
- In addition, an intervention is proposed to electrify 90% of commercial and industrial heating systems and processes up to 2050, which would see kerosene and gas combustion units replaced with heat pumps and electric boilers. For the residual systems and processes that cannot be electrified, GHG emissions can be reduced by switching to using locally produced biomethane from 2035, as set out in Waste Management section below, and use only renewable fuels from 2050 onwards when a proposed ban on the use of conventional fuels takes effect.

Implementing the interventions summarised above would require an investment of ~£293m, comprised of ~£90m for energy efficiency measures and ~£203m for electrification.

For the Business sector, encouraging these changes would require the States of Guernsey to develop policies that communicate a clear direction to commercial and industrial organisations that it will be necessary to electrify heating and processes or switch to using renewable fuels up to 2050. For newly built premises and facilities, the States of Guernsey could require electric heating to be used. The States of Guernsey could also help businesses to identify and report their emissions and introduce an EPC scheme that enables current and future owners and tenants of commercial premises to understand the current and possible level of energy efficiency and emissions, and which might also play a role in setting the level of taxation.

To encourage the implementation of energy efficiency measures and electrification, and adoption of renewable fuels, a coordinated set of incentives and disincentives could be introduced. For example, this might involve the offer of grants to smaller businesses to introduce electric heating in existing premises, which could be funded in part or whole by phasing in direct carbon taxes on organisations that use ICE plant and equipment (or levying duties on conventional fuels), or phasing in indirect carbon taxes on, for example, overnight stays to contribute towards carbon reduction interventions.

Electricity Supply

In the Baseline pathway, GHG emissions in the Electricity Supply sector reduce from 25 $ktCO_2e$ to 2 $ktCO_2e$ up to 2050, a 23 $ktCO_2e$ reduction over the period.

With the implementation of the Electricity Strategy assumed within the Baseline pathway, as described in section 3.4, the same level of change is included in the Moderate pathway because the GHG emissions associated with the implementation of the Electricity Strategy reduces the existing level of emissions by 92% up to 2050.

For the Electricity Supply sector, policy-related considerations were outlined in the Electricity Strategy and are directly applicable to achieving sector decarbonisation.

F-gases

In the Baseline pathway, GHG emissions in the F-gases sector reduce from 14 $ktCO_2e$ to 4 $ktCO_2e$ up to 2050, a 10 $ktCO_2e$ reduction over the period. F-gas emissions are projected to reduce by 70% in the Baseline pathway due to the close alignment of imported products with UK regulations, as outlined in section 3.5.

In the Moderate pathway, a reduction in GHG emissions can be achieved by accelerating the targeted replacement of refrigeration and condensing units, particularly in commercial and industrial environments, and using Dry Powder Inhalers (DPI) instead of metered dose inhalers. By 2050, this intervention could save an additional 3 $ktCO_2e$ of GHG emissions compared to the Baseline pathway, at an estimated cost of £1.7m.

Accelerating these changes would require the States of Guernsey to develop policies that communicate a clear direction to businesses and medical practitioners to consider replacing existing refrigerants and prescribing suitable alternative medications, and consider phasing in a ban on the import of appliances and devices that contain hydrofluorocarbons (HFCs).

In respect to heat pumps, which is key to electrification of heating, this direction should be established early to educate and encourage households and businesses to choose the best available options.

Land & Forestry

In the Baseline pathway, Guernsey's Land & Forestry sector emitted 5.5 $ktCO_2e$ and sequestered 7.7 $ktCO_2e$, which resulted in a net sequestration of 2.2 $ktCO_2e$.

In the Moderate pathway, the same level of net sequestration is assumed, which will require Guernsey to maintain the existing levels of woodland and grassland up to 2050 and beyond. This will require sustainable woodland and grassland management practices that balance ecological, social and economic needs to protect and manage the existing woodland carbon sinks and associated biodiversity, and a principle of net-gain would apply if areas of woodland are allocated for development. This intervention assumes no investment.

From a policy development perspective, the States of Guernsey should ensure that the composition of land is classified by type (grassland, woodland etc.) with areas and quantities monitored. Given that there will be pressures and applications to develop on these areas, policies might ensure that there is a principle of net gain and might also consider establishing an urban forest scheme that encourages tree planting in gardens, towns and parishes, which could increase sequestration levels and offer other benefits, such as character, wellbeing, biodiversity, climate resilience etc.

Residential

In the Baseline pathway, GHG emissions in the Residential sector reduce from 64 $ktCO_2e$ to 11 $ktCO_2e$ up to 2050, a 53 $ktCO_2e$ reduction over the period. With the majority of GHG emissions in the Residential sector associated with space and water heating, as described in section 3.7, the 83% reduction in the level of emissions is expected due to electrification of heating systems, as modelled in the Electricity Strategy.

In the Moderate pathway, an additional 11 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by applying a range of interventions to improve the fabric and energy efficiency of homes and switch to using renewable fuels:

- Retrofitting 97% of homes up to 2050 with fabric and energy efficiency measures, and constructing new homes from 2025 onwards to the UK's Future Homes Standard, would reduce the heat load demand across the building stock by 46% and reduce ongoing energy bills. This would result in an additional 4 $ktCO_2e$ reduction by 2050 compared to the Baseline pathway. Introducing the energy efficiency measures is estimated to require a total investment of ~£73m in addition to the Baseline pathway.
- A further 6 $ktCO_2e$ of GHG emissions could be reduced by switching any residual domestic heating systems to locally produced biomethane from 2030, or other imported renewable fuels from 2050. Given that this can be achieved relatively quickly, subject to availability of the fuel, this can have a beneficial effect early on within the pathway.

For the Residential sector, encouraging these changes would require the States of Guernsey to develop policies with clear timelines and communicate to households what types of heating systems will be permitted. For example, a policy may require electric heating systems in newly built homes and allow a choice of either electric heating or renewable fuels in existing homes. This might include introducing a ban on replacement gas- and oil-fired boilers from 2030 and/or introduce a ban on the availability of conventional fuels from 2050 onwards. The States of Guernsey could also introduce an EPC scheme that enables home owners and tenants to understand the current and possible level of energy efficiency and emissions, and this might play a role in the calculation of Tax on Real Property (TRP) levied on dwellings.

To encourage the implementation of energy efficiency measures and electrification, and adoption of renewable fuels, a coordinated set of incentives and disincentives could be introduced. For example, this might involve the offer of grants to home owners for energy efficiency measures and electric heating systems that are introduced into existing premises, which could be funded in part or whole by phasing in a higher level of Tax on Real Property (TRP) levied on dwellings without such measures. Additionally, to encourage the adoption of renewable heating fuels, duties could be removed or reduced from renewable fuels and introduced or increased on conventional fuels.

Transport (Aviation)

In the Baseline pathway, GHG emissions in the Aviation sector are projected to remain broadly unchanged at 20 $ktCO_2e$ up to 2050, as shown in section 3.8.1. This assumes that Scenario 1 of the UK's Jet Zero Strategy is applied.

In the Moderate pathway, a 10 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by aligning with Scenario 2 of the UK's Jet Zero Strategy[45] in respect to fuels, fuel efficiency and zero emissions aircraft movements. This increases the

[45] UK Jet Zero Strategy: Delivering Net Zero Aviation by 2050

percentage of SAF to 50% of total fuel consumption by 2050 and aims for a 2% annual improvement in fuel efficiency, and 27% of air traffic movements made in zero emissions aircraft by 2050.

From a policy development perspective, the States of Guernsey should encourage the use of SAF, which might involve phasing in targets for the use of SAF and applying differing levels of duty on conventional and renewable fuels to reduce the effects of differential fuel costs. Additionally, the States of Guernsey might need to support the airport in investing in infrastructure (e.g., storage tanks and tankers) to enable the transition toward using renewable fuels. However, Guernsey will largely rely on industry development for decarbonisation of the sector.

Transport (Maritime)

In the Baseline pathway, GHG emissions in the Transport (Maritime) sector are projected to increase from 13 $ktCO_2e$ to 14 $ktCO_2e$ up to 2050, as shown in section 3.8.2. Marine gas oil accounts for 99% of the emissions and a 6% increase in fuel use, which increases emissions by 1 $ktCO_2e$ up to 2050, is due to the anticipated growth in Guernsey's population after the effects of positive net-migration.

In the Moderate pathway, a 14 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by applying three interventions to improve the fuel efficiency of vessels, replace with electric vessels and switch existing vessels to using renewable fuels:

- 1 $ktCO_2e$ of annual GHG emissions can be reduced up to 2050 by improving fuel efficiency by 10% across all marine vessels, achieved by actively encouraging the turnover of inefficient vessels, particularly by replacing them with highly efficient hydro foiling options, and, for existing vessels, applying different hull coatings to reduce drag, improving propulsion systems, reducing vessel speed, and optimising route selection.
- From 2030, 4 $ktCO_2e$ of annual GHG emissions can be reduced up to 2050 by replacing approximately 25% of all vessels to use electric powered engines, charged from renewable electricity generation, and gradually switching the other 75% of vessels to using alternate fuels, such as locally produced biomethane (see Waste Management below) or imported ammonia and bio fuels. This would necessitate a switching of 50% of fuel oil powered vessels (accounts for 1% of marine fuel dispensed in Guernsey, typically used by large vessels) and 20% of gas oil powered vessels (accounts for 99% of marine fuel dispensed in Guernsey, typically used by fishing and small vessels) to using biofuels or ammonia by 2035.
- From 2050, 9 $ktCO_2e$ of annual GHG emissions can be reduced by necessitating all remaining combustion powered vessels to switch to using renewable fuels, achieved by introducing a ban on importing conventional fuels from 2050 onwards.

Introducing the three interventions outlined above is estimated to require a total investment of ~£46m in addition to the Baseline pathway for the interventions.

For the Maritime sector, encouraging these changes would require the States of Guernsey to develop policies that communicate a clear direction to commercial and private boat owners regarding a transition towards electric-powered vessels for shorter journeys and leisure purposes, and switching to using away from conventional fuels to biofuel or ammonia with an eventual 'sunsetting' date on the availability of conventional fuels.

To encourage the adoption of electric-powered vessels and renewable fuels, the States of Guernsey might consider offering grants to support the implementation of necessary infrastructures (e.g., shoreside or offshore charging), which could be funded in part of whole by phasing in higher duties on conventional marine fuels, and possibly considering carbon taxes based on visiting cruise ship passengers.

Transport (On-Island Travel)

In the Baseline pathway, GHG emissions in the Road Transport sector reduce from 66 $ktCO_2e$ to 4 $ktCO_2e$ up to 2050, a 62 $ktCO_2e$ reduction over the period. This reduction is attributed to the electrification of 95% of road vehicle up to 2050 in the Baseline pathway, as outlined in section 3.8.3, resulting in residual 4 $ktCO_2e$ of annual emissions.

In the Moderate pathway, an additional 4 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by implementing and a set of five interconnected interventions, which are in line with Guernsey's Integrated Travel Strategy[46]:

- A first intervention, on topic of 'active travel', proposes to increase the percentage share of active travel journeys, which is currently estimated at 5% of all journeys. This could be achieved by introducing marked bike lanes across 20% of Guernsey's road network, providing up to 500 sharing bikes across up to 50 cycling hubs, and supporting active travel commuter schemes by 2035.
- A second intervention, on topic of 'public transport', proposes subsidies for public transport and provision of 100 vehicles that offer on demand transport services by 2035.

[46] States of Guernsey - On-Island Integrated Transport Strategy

- A third intervention, on topic of 'efficiency improvement', proposes that unnecessary car usage is discouraged by introducing parking fees and dynamic tolling on 20% of all car parking spaces and road networks by 2035, and offer sustainable driving training.
- A fourth intervention, on topic of 'sharing economy', incentivises car sharing by providing free parking options for vehicles with multiple occupants. In addition, 500 micro EVs are introduced by 2035 in a sharing scheme, which will reduce the number of privately owned cars sevenfold.
- A fifth intervention, on topic of 'electrification and switching to alternate fuels', aligns with other sectors in that it will replace any residual fossil fuels with locally produced biomethane from 2035 and imported renewable fuels from 2050.

Together, these interventions will reduce annual emissions by another 4 $ktCO_2e$ in 2050 compared to the Baseline pathway, achieving near zero emissions. The additional investment required for these interventions is estimated to be £109m in total.

For the Road Transport sector, encouraging these shifts would require the States of Guernsey to develop policies to provide citizens with an Island-wide network of safe walking and cycling routes, and provide private investors and operators with confidence that the implementation of bike and car sharing schemes and public transport will be backed by Government commitment to dissuade car ownership and journeys.

To encourage increases in active travel and used of public and shared transport, and encourage reductions in car journeys and vehicle ownership, the States of Guernsey could introduce higher levels of road fuel duties, together with charges for vehicle ownership, usage and parking, to contribute towards investment in active, public and shared travel schemes.

The suggested sizings of the shared cycling and car schemes and public transport is aimed at materially reducing the need for private vehicle ownership and transforming the travel modal shift for citizens, not only visitors. If Guernsey implemented a smaller scheme, then this would have the effect of 'adding back' private vehicles to roads and associated emissions. For example:

- Reducing from 500 bikes available from 50 hubs to 200 bikes available from 20 hubs in this Moderate pathway would retain ~600 private ICE vehicles on Guernsey's roads, which would be equivalent to ~1.23 ktCO2e/year of emissions.
- Reducing from 500 to 100 micro EVs in the Moderate pathway would retain ~2,800 private ICE vehicles on Guernsey's roads, which would be equivalent to ~5.72 ktCO2e/year of emissions.

Waste Management

In the Baseline pathway, waste related emissions reduce from 42 $ktCO_2e$ to 8 $ktCO_2e$ up to 2050, which is achieved due to declining emissions from the historical use of on-Island landfills, as described in section 3.9, and the current policy of exporting organic food waste and Refuse Derived Fuel (RDF) is assumed to continue.

In the Moderate pathway, no additional reductions in waste related emissions are projected because this would necessitate reductions in the levels of solid waste and wastewater that originate from residences and organisations. Instead, a 'circular economy' intervention is proposed to locally produce 2.5m litres of biomethane each year from 2035, using 5,000 tonnes/year of agricultural waste, 4,882 tonnes/year of food waste and 118 tonnes/year of meat rendering waste. Together with an appropriate tonnage of wastewater that is collected from septic tanks by road tanker, a local Anaerobic Digestion (AD) plant would produce the biomethane with an estimated carbon intensity of 0.00038 $kgCO_2e/kWh$[47], which would reduce the use of fossil fuels in the Business, Residential and Transport (fuel may be used in road vehicles and/or marine vessels) sectors, and reduce the emissions in those sectors. 2.5m litres is enough for 16.5m road vehicle miles, and based on an assumed 4,000 miles per vehicle per year, would meet the demand of more than 4,100 vehicles on Guernsey's roads.

By implementing an AD plant, emissions that are currently not reported within Guernsey's GHG inventory could be saved (assumes like for like performance and efficiency levels) as highlighted by Figure 21. Regarding the GHG inventory, note that the -496.17 tCO_2e shown below would not reduce emissions reported for the Waste sector. Instead, this benefit would be seen in the sector (or sectors) that would combust the biomethane, as an alternative to combusting conventional fuel.

[47] UK Gov – GHG Conversion Factors 2022

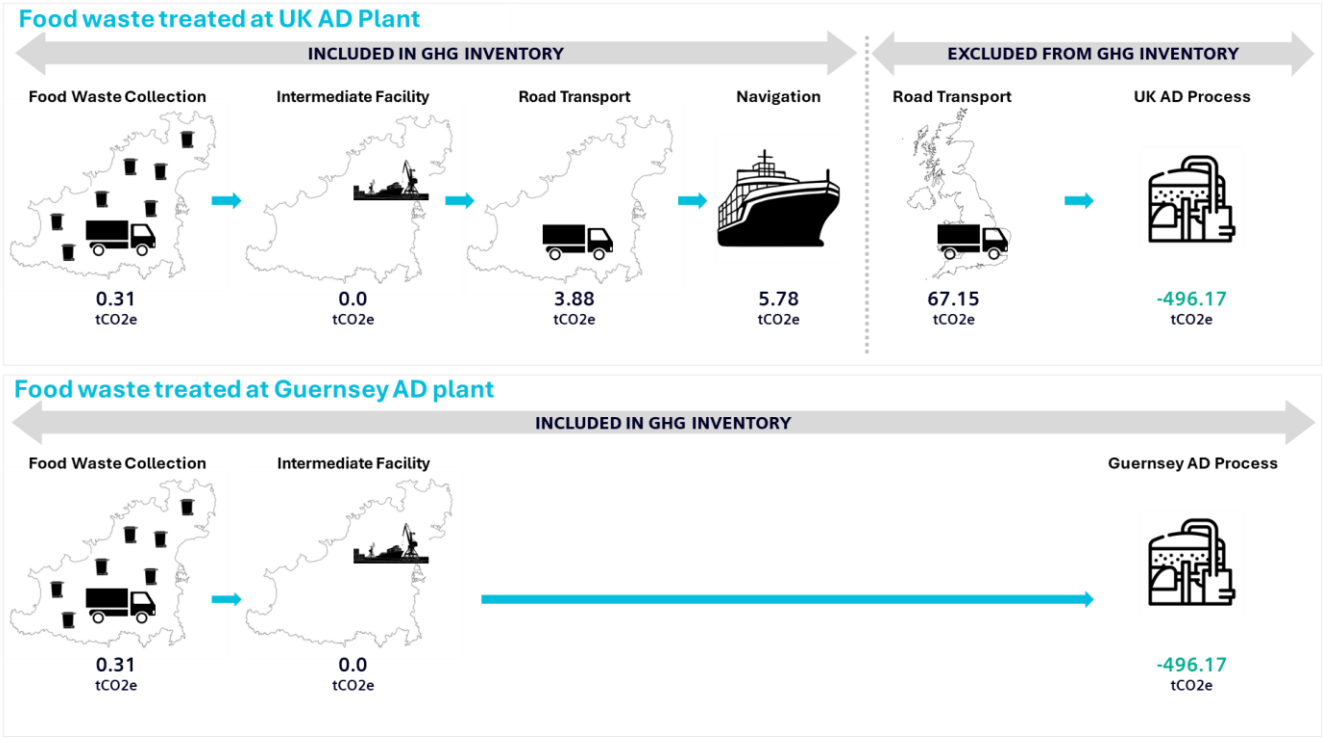


Figure 21: Comparison of food waste emissions based on an AD plant in the UK or Guernsey

The investment required for an AD processing plant in Guernsey is estimated to be £10m.

From a policy development perspective, the States of Guernsey would need to approve the principle of producing biomethane in a local AD plant instead of exporting organic food waste, and allocate a site for such a facility to be constructed and operated. Additionally, this policy will need to consider transportation of feedstocks and infrastructure connections for the produced biomethane, as well as any other additional constraints. Such a policy could be used to attract private investment and could be operated by a private contractor.

4.2 Ambitious Pathway

In comparison to the Moderate pathway that produces 27 $ktCO_2e$ of emissions in 2050, the level of emissions in an Ambitious pathway could be reduced to 12 $ktCO_2e$ in 2050, a further 15 $ktCO_2e$ reduction. Mostly, the Ambitious pathway proposes the same interventions as those proposed in the Moderate pathway but with an aim to reduce emissions faster and further compared to the Moderate pathway. Additionally, several new interventions are proposed regarding off-Island travel, energy from waste and use of carbon capture technologies. Compared to the Moderate pathway, the key changes in each sector together with the positive impact on emissions is summarised below:

- The Transport sector can achieve an additional 8 $ktCO_2e$ reduction in GHG emissions up to 2050 through the implementation of more determined transitions to SAF and alternative modes of transport between Guernsey and the Channel Islands.
- The Agriculture sector can achieve an additional 3 $ktCO_2e$ reduction in GHG emissions up to 2050 by continuing to meet dairy requirements from further reduced cattle demand.
- The Electricity Supply sector can achieve an additional 2 $ktCO_2e$ reduction in GHG emissions up to 2050 by increasing the size of the proposed offshore windfarm and importing zero carbon electricity from France.
- In addition to the 2.2 $ktCO_2e$ of GHG emissions that are currently sequestered by Guernsey's natural environment, the Waste Management sector could contribute to capturing and storing 3 $ktCO_2e$ by processing wastewater and solid wastes, achieved when processing wastewater and solid waste into biomethane BioLPG fuels, respectively.
- With the Business, F-gases and Residential sectors each producing less than 1 $ktCO_2e$ of GHG emissions in the Moderate pathway in 2050, the interventions in the Moderate are proposed earlier and at greater scale with the aim to reduce Guernsey's cumulative GHG emissions over the period of the pathway.
- For all sectors, using only renewable fuels from 2035 onwards.

Overall, the Ambitious pathway can achieve a 96% reduction in GHG emissions by 2050 compared to 2022, as shown in Figure 22, and an 56% reduction compared to the Moderate pathway's 27 $ktCO_2e$ emissions in 2050.

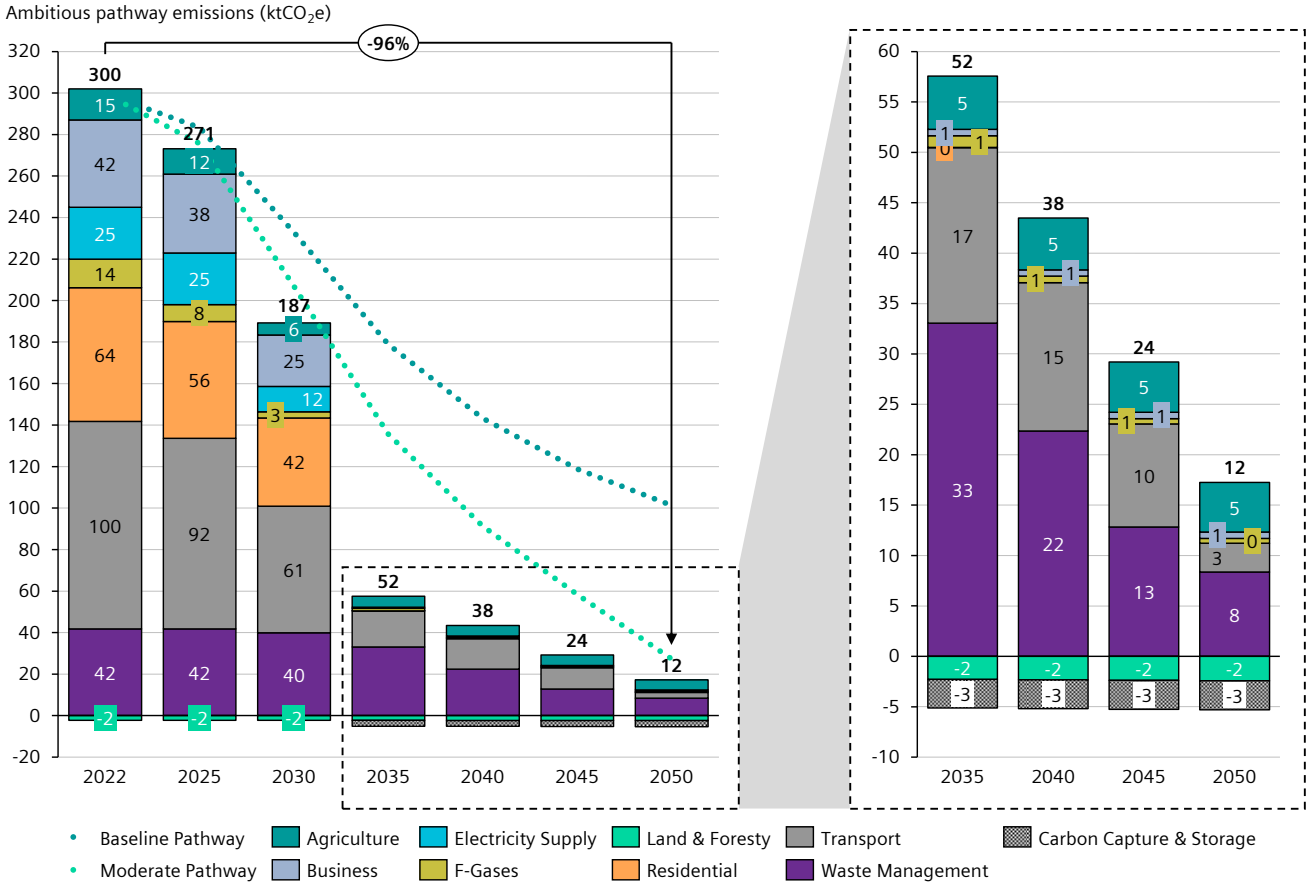


Figure 22: Ambitious pathway

The additional investment required for the Ambitious pathway up to 2050 compared to the Moderate is estimated to be in the region of £469m, as shown in Table 9 with a breakdown by sector. Note that 87% of the investment relates to the implementation of the Anaerobic Digestion (for wastewater) and Gasification (for RDF) plants, larger-scale implementation of the active, public and shared transport assets (e.g., bikes, EVs, buses, water taxis) and additional cycle lanes in the Transport sector, and increased size of offshore wind generation in the Electricity Supply sector.

Table 9: Additional investment in the Ambitious pathway by sector compared to the Moderate pathway

Sector	Additional Investment compared to Moderate £m	Additional Emission Reduction (or Capture) by 2050 compared to Moderate $ktCO_2e$/year
Agriculture	6	2.6
Business (Including Industrial Processes)	0	-
Electricity Supply	50	1.6
F-gases	3	0.4
Land & Forestry	-	-
Residential	0	-
Transport (Aviation)	15	7.8
Transport (Maritime)	5	-
Transport (On-Island Travel)	170	-
Waste Management	220	2.9 (CCS)
Total	**469**	**15.3**

A direct comparison of indicative investment required up to 2050 to achieve the Baseline, Moderate and Ambitious pathways is additionally shown in Table 10, which includes a breakdown by decarbonisation theme and intervention, together with possible sources of investment, and benefits that include carbon savings, energy savings and GVA for Guernsey's economy.

Further detail of the interventions, together with timelines, expenditures and positive impact on reducing GHG emissions in the Ambitious pathway, is set out below for each sector (refer also to Section 5 of this report that sets out the interventions in full detail). Consideration for policy development, together with incentives and disincentives, is also outlined below for each sector (refer to Table 12 for a summarised version).

Agriculture

In the Moderate pathway, GHG emissions in the Agriculture sector reduce from 15 $ktCO_2e$ to 8 $ktCO_2e$ up to 2050, a 7 $ktCO_2e$ reduction over the period.

In the Ambitious pathway, an additional 3 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by reducing dairy cattle numbers by 50% up to 2030. This can be possible partly due to an anticipated reduction in consumer demand for dairy products, and through the implementation of highly efficient processes, such as robotic milking systems. By 2030, this would result in approximately 700 fewer dairy cattle heads under the Ambitious scenario, compared to the Moderate scenario. The additional investment related to farmers and the farming practices they adopt is estimated to be £6m.

To encourage the implementation and adoption of new farming practices, this might require the offer of grants or subsidies to support the investment in robotic milking systems, and phasing in a carbon tax per head of livestock to encourage improvements in production yields.

Business (including industrial processes)

In the Moderate pathway, GHG emissions in the Business sector reduce from 42 $ktCO_2e$ to 1 $ktCO_2e$ up to 2050, a 41 $ktCO_2e$ reduction over the period.

In the Ambitious pathway, the emissions are curtailed earlier by implementing and achieving the level of interventions outlined in the Moderate pathway sooner. This includes:

- Retrofitting 95% of commercial and industrial buildings with passive energy efficiency measures (e.g., insulation, airtightness, ventilation and solar shading) and active energy efficiency measures (e.g., building systems with smart controls and waste heat recovery etc.) up to 2040, 10 years earlier compared to the same level of intervention in the Moderate pathway.
- Electrifying 90% of commercial and industrial heating systems and processes up to 2040, 10 years earlier compared to the same level of intervention in the Moderate pathway.

- Requiring residual systems to use renewable fuels that are produced on-Island or imported from 2035 onwards, 15 years earlier compared to the same intervention in the Moderate pathway.

Implementing and achieving these interventions earlier would generally be cost neutral compared to the Moderate pathway, however the investment would be incurred sooner.

To encourage the earlier implementation of energy efficiency measures and electrification, and adoption of renewable fuels, the States of Guernsey may need to elevate the level of grants to smaller businesses to encourage their earlier take-up, and possibly consider a time-limited offer that is then superseded by the phasing in of duties and carbon taxes.

Electricity Supply

In the Moderate pathway, GHG emissions in the Electricity Supply sector reduce from 25 $ktCO_2e$ to 2 $ktCO_2e$ up to 2050, a 23 $ktCO_2e$ reduction over the period.

In the Ambitious pathway for the Electricity sector, a new intervention is proposed compared to the Baseline and Moderate pathways, which would increase the size of the offshore windfarm deployment in 2035 by 15 MW. Together with the assumption that any imported electricity via the GF1 interconnector will have a 0 gCO_2e/kWh carbon intensity factor by 2035, this would result in a 2 $ktCO_2e$ reduction compared to the Moderate pathway. The estimated cost for this intervention is £50m.

F-gases

In the Moderate pathway, GHG emissions in the F-gases sector reduce from 14 $ktCO_2e$ to 3 $ktCO_2e$ by 2030 and less than 1 $ktCO_2e$ up to 2050, a more than 13 $ktCO_2e$ reduction over the period.

In the Ambitious pathway, it is proposed that the replacement of refrigeration and condensing units in commercial and industrial environments, and use of Dry Powder Inhalers (DPI) instead of metered dose inhalers occurs sooner. This accelerated speed of uptake of low GWP HFCs such as HFC-32 and other HFC alternatives would result in GHG emission reductions of less than 0.5 $ktCO_2e$ by 2050 compared to the Moderate pathway. The estimated cost for this intervention is £2.8m and would be dependent on international standards and availability of supplies.

To encourage the earlier replacement of refrigeration and condensing units, the States of Guernsey should consider incorporating the type of heating and cooling system into a future EPC scheme for the Business sector. To encourage the earlier adoption of Dry Power Inhalers (DPI), the States of Guernsey should engage early with medical practitioners to initiate their evaluation of low GWP alternatives.

Land & Forestry

The Baseline, Moderate and Ambitious pathways include a net sequestration level of 2.2 $ktCO_2e$ in connection with the natural environment. Several interventions were considered, which included increasing the level of woodland and introducing seagrasses into Guernsey's waters:

- Based on discussions with States of Guernsey stakeholders, the considered view is that woodland is at an optimal level, given the recent completion of tree planting schemes.
- Assuming that up to 15% of Guernsey's coastline could be used for planting seagrasses, which assumes a 100-metre width, 0.05 $ktCO_2e$/year of emissions could be sequestered.

Based on above, it was concluded that whilst it will be possible to increase the level of sequestration in the natural environment, and such activities will improve both environment and biodiversity, achieving significant levels of sequestration would be better achieved using existing and emerging carbon capture technologies (refer to Waste Management section below and refer back to Table 3).

This intervention assumes no investment.

Residential

In the Moderate pathway, GHG emissions in the Residential sector reduce from 64 $ktCO_2e$ to almost 0 $ktCO_2e$ up to 2050, a 64 $ktCO_2e$ reduction over the period.

In the Ambitious pathway, the emissions are curtailed earlier by implementing and achieving the level of interventions outlined in the Moderate pathway sooner. This includes:

- Constructing new homes from 2025 onwards to the UK's Future Homes Standard.
- Retrofitting 97% of homes with fabric and energy efficiency measures up to 2040, 10 years earlier compared to the same level of intervention in the Moderate pathway.
- Requiring residual heating systems to use renewable fuels that are produced on-Island or imported from 2035 onwards, 15 years earlier compared to the same intervention in the Moderate pathway.

Implementing and achieving these interventions earlier would generally be cost neutral compared to the Moderate pathway, however the investment would be incurred sooner.

To encourage the earlier implementation of energy efficiency measures and electrification, and adoption of renewable fuels, the States of Guernsey may need to elevate the level of grants to encourage homeowners to introduce energy efficiency measures and switch to electric heating or renewable fuels, and possibly consider a time-limited offer that is then superseded by the phasing in of duties on conventional fuels and a higher level of Tax on Real Property (TRP) levied on dwellings that use conventional heating systems.

Transport (Aviation)

In the Moderate pathway, GHG emissions in the Aviation sector reduce from 20 $ktCO_2e$ to 11 $ktCO_2e$ up to 2050, a 10 $ktCO_2e$ reduction (with rounding) over the period. This assumes that Scenario 2 of the UK's Jet Zero Strategy is implemented in respect to fuels, fuel efficiency and zero emissions aircraft movements, which assumes a 50% usage of SAF by 2050.

In the Ambitious pathway, a further 8 $ktCO_2e$ reduction in GHG emissions can be achieved up to 2050 by:

- Aligning with Scenario 3 of the UK's Jet Zero Strategy, which assumes 100% usage of SAF by 2050, instead of 50%.
- Introducing a new intervention that aims to replace all flights between Guernsey and the Channel Islands with a high-speed water taxi service from 2030 that would operate to a fixed and frequent schedule, which in turn would use electrically powered vessels.

The estimated investment for the vessels to introduce a water taxi services would be approximately £15m.

Note that a rail tunnel between Guernsey and France via Jersey is not specifically considered. If such an infrastructure project were implemented, this could be implemented instead of introducing a water taxi service, and would achieve the same beneficial level of GHG emission reduction in the GHG inventory.

Policy development would be required, with support from Guernsey's ports (air and sea) and airline, and governing authorities of other Channel Islands, to enable the successful introduction and scaling up of a high-speed water taxi service and an eventual phasing out of air travel between Guernsey and the Channel Islands.

Transport (Maritime)

In the Moderate pathway, GHG emissions in the Maritime sector reduce from 13 $ktCO_2e$ to 0 $ktCO_2e$ up to 2050, a 14 $ktCO_2e$ reduction after considering the effect of a 1 $ktCO_2e$ increase up to 2050 in the Baseline pathway.

In the Ambitious pathway, the emissions are curtailed earlier by implementing and achieving the level of interventions outlined in the Moderate pathway sooner. This includes:

- Reducing fuel demand by an average of 23% across all vessels up to 2050, achieved by efficiency gains from a range of improvements such as fleet turnover and use of hydro foiling.
- Replacing approximately 25% of all vessels to use electric powered engines (same as Moderate pathway) up to 2050.
- Switching 60% of fuel oil powered vessels (accounts for 1% of marine fuel dispensed in Guernsey, typically used by large vessels) and 50% of gas oil powered vessels (accounts for 99% of marine fuel dispensed in Guernsey, typically used by fishing and small vessels) to using biofuels or ammonia by 2035.
- Introducing a ban on importing conventional fuels from 2035 onwards, 15 years earlier than the Moderate pathway.
- Introducing on-vessel carbon capture and storage (CCS) on larger vessels from 2045, which could result in 0.5 $ktCO_2e$ being stored between 2045 and 2050.

The investment for accelerating the transition to alternate fuels and capturing carbon onboard vessels is an estimated £4.5m.

Encouraging an accelerated uptake of electric-powered vessels and renewable fuels, and encouraging the introduction of carbon capture technologies on vessels would be largely regarded as outside of the States of Guernsey's direct control, given that vessel choices will be determined by recreational boat owners and commercial operators. However, the States of Guernsey could consider introducing an Ultra Low Emission Zone (ULEZ) at ports and marinas (possibly at a re-developed St. Sampson Port), or phase in taxes/levies that could be applied to shoring/mooring fees and fuels, which prioritise vessels, for example, with sails and electric motors, and/or apply differential duties to renewable and conventional marine fuels.

Transport (On-Island Travel)

In the Moderate pathway, GHG emissions in the Road Transport sector reduce from 66 $ktCO_2e$ to almost 0 $ktCO_2e$ up to 2050, a 66 $ktCO_2e$ reduction over the period. This reduction is attributed to the electrification of 95% of road vehicle up to 2050 in the Baseline pathway, together with the implementation and adoption of active travel, public transport and bike and vehicle sharing measures in the Moderate pathway.

In the Ambitious pathway, the scale of the interventions in the Baseline and Moderate pathways are scaled up with an aim to achieve reduce car ownership and traffic levels, and reduce Guernsey's emissions much sooner.

Compared to the Baseline pathway, the 'electrification of vehicles' will push for 99% of vehicles to be EVs by 2050, instead of 95%; and all remaining ICE vehicles will exclusively use locally generated renewable biofuels from 2035. The additional investment required is estimated to be approximately £170m.

Compared to the Moderate pathway:

- The 'Active Travel' intervention requires 50% of Guernsey's road network to provide safe cycling routes compared to 20% of Guernsey's road network in the Moderate pathway, and a bike sharing scheme would offer 1,000 e-bikes across 75 stationary hubs, instead of 500 standard bikes across 50 stationary hubs.
- For the 'Public Transport' intervention, a flexible and free of charge service would be delivered by 1,200 vehicles rather than 100, comprised of a fleet of larger buses (e.g., current fleet) and introduction of smaller mini-bus sized vehicles, each seating up to 10 passengers.
- The number of EV microcars introduced under the 'Sharing Economy' intervention doubles to 1,000.
- The 'efficiency improvement' intervention introduces parking fees to 100% of public car parking spaces that are used by privately owned vehicles and dynamic tolling to 100% of Guernsey's road networks, compared to 20% in the Moderate pathway.
- Pull forward a ban on new ICE vehicles from 2035 to 2030.

This scale of implementation would be necessary to achieve materially lower levels of vehicle ownership and traffic levels. Without the electrification of vehicles, by introducing these schemes early and achieving the full benefits, it could be possible to remove 29,000 vehicles from Guernsey's roads, equivalent to more than 50% of the 57,000 vehicles that are present currently. As a result, Guernsey's road transport emissions would reduce by 27 ktCO2e, from 66 ktCO2e currently.

Introducing the active, public and sharing schemes above will involve a highly significant investment and operational cost, and will likely add more vehicles to roads initially. However, Guernsey's citizens would be provided with a choice of travel modes that are widely accessible and available and, in the case of public transport, free. To introduce such a scheme in an affordable way, it will be necessary to communicate a bold ambition and obtain buy-in from the whole community, which will provide private investors and operators with the right risk and reward opportunity. When introducing such a scheme, it will be necessary to phase and scale disincentives to car ownership, which should mean higher fuel prices, together with prohibitive charges for car parking, journey tolls when owning and using a private vehicle.

Waste Management (including Carbon Capture & Storage)

In the Baseline and Moderate pathways, waste related emissions reduce from 42 $ktCO_2e$ to 8 $ktCO_2e$ up to 2050, which is achieved due to declining emissions from the historical use of on-Island landfills.

In the Ambitious pathway, no additional reductions in waste related emissions are projected because this would necessitate reductions in the levels of solid waste and wastewater that originate from residences and organisations. Instead, two further 'circular economy' interventions are proposed, which will utilise Guernsey's wastewater and solid waste (Refuse Derived Fuel) as feedstocks for additional biomethane production, and BioLPG production.

Firstly, a wastewater treatment plant can process the Island's 12.5m litres of daily wastewater from 2035 onwards to produce an additional 11m litres of liquid biomethane using a closed-system AD process with CCS, with fuel used in road vehicles and/or marine vessels). 11m litres is enough for 72.5m road vehicle miles, and based on an assumed 4,000 miles per vehicle per year, would meet the demand of more than 18,100 vehicles on Guernsey's roads. The subsequent carbon that is captured in tanks does not constitute sequestered carbon, and would require further management or disposal to avoid it being released into the atmosphere. Figure 23 shows the change in the wastewater's processing journey by implementing this intervention (assumes like for like performance and efficiency levels) and highlights that 2.7 $ktCO_2e$ of annual emissions could be captured from the original 4.5 $ktCO_2e$ of sewage sludge emissions. The investment cost for this intervention is estimated to be £90m.

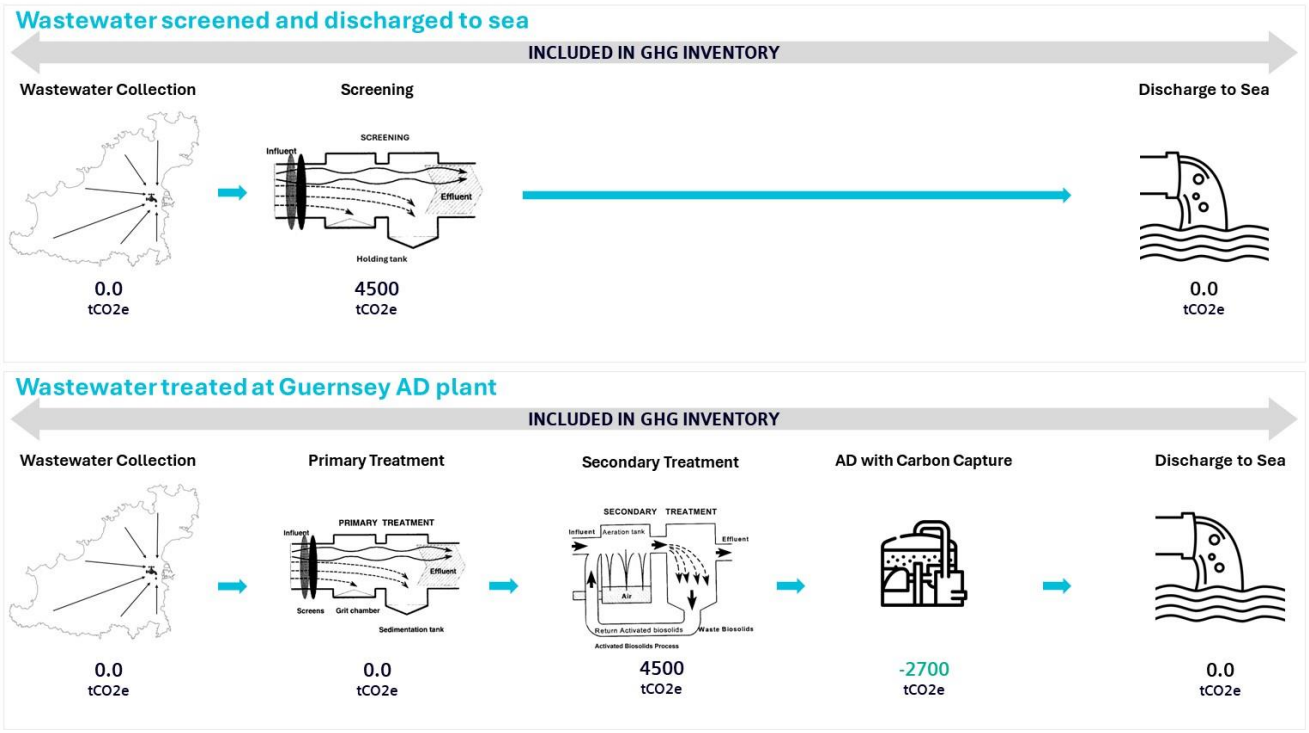


Figure 23: Comparison of wastewater emissions based on direct-to-sea discharge or AD plant in Guernsey

Secondly, an Energy Recovery Facility (ERF) could process the 17,785 tpa of RDF waste and 4,282 tpa of biomass waste to produce 11m litres of BioLPG in 2035 via a gasification process. This volume of BioLPG would be enough to heat approximately 5,600 typical homes, assuming 13,200 kWh/year per household. Figure 24 shows that processing this waste on-Island would mean that Guernsey mitigates all transportation and landfill emissions that are excluded from Guernsey's GHG inventory, reduces 26.4 tCO_2e from the road transport and navigation emissions that are required to export the waste, and requires the use of local landfill for resulting waste from BioLPG production, which adds 7.7 tCO_2e.

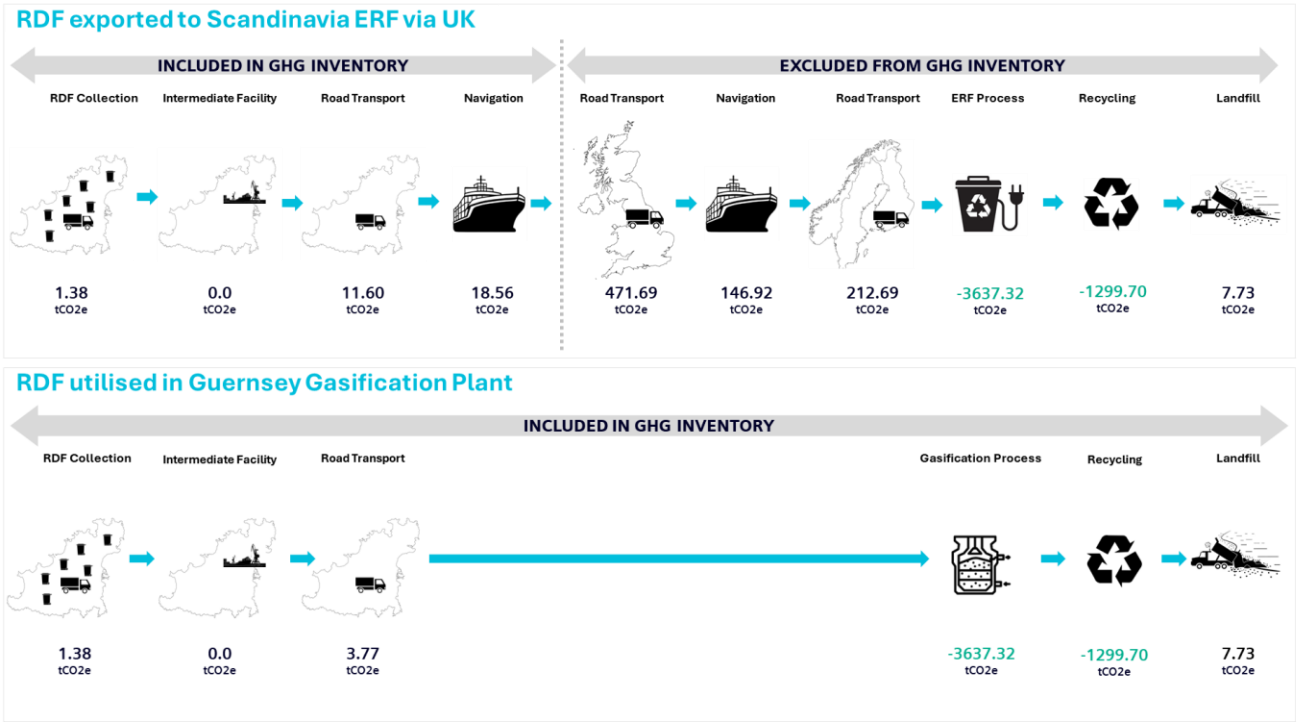


Figure 24: Comparison of RDF material emissions based on energy recovery in Scandinavia or Guernsey

When operating an Energy Recovery Facility (ERF) using a gasification process, note the following:

- A carbon capture offset in the GHG inventory would not be reported for the Waste sector. Instead, the sectors that combust the renewable fuels would report lower levels of emissions e.g., the Business, Residential and Transport sectors.
- Whilst the resulting waste from a gasification process would add 7.7 tCO_2e to Guernsey's landfill emissions in the GHG inventory, using Guernsey's landfill for the collected Refuse Derived Fuel (e.g., before gasification) would generate higher emissions, between 1.5 to 2.0 times that level.

The investment cost for an ERF facility is estimated to be in the region of £130m.

Regarding policy development, the States of Guernsey would need to approve the principle of producing BioLPG in addition to biomethane, amend or develop policies consider the treatment of wastewater and gasification of solid waste, and allocate suitable sites for the construction of infrastructure. This will attract private investment and private operators, with a public and private partnership for wastewater treatment (e.g., public) and AD production (e.g., private).

4.3 Indicative and Comparative Investment required for each Pathway

A direct comparison of indicative investment required up to 2050 to achieve the Baseline, Moderate and Ambitious pathways is shown in Table 10, together with investment contributors, carbon savings and estimated benefits.

Table 10: Required investment and contributors with estimated benefits for the interventions

		Investment £m			Contributors				Carbon Saved* ktCO2e	Energy Savings** £m/year	GVA £m/year
Theme	Intervention	Baseline	Moderate	Ambitious	Public	Investors	Businesses	Citizens			
Increase efficiency levels and reduce demand	Increase Energy Efficiency of Residential Buildings using Energy Certifications	48	73	73	x		x	x	1.1 – 8.7	6 – 14	25 – 38
	Increase Energy Efficiency of Commercial & Industrial Buildings and Processes		90	90	x		x		2.3	2	48
	Improve the efficiency of marine vessels		6	6	x		x	x	1.2 – 2.4	1 – 3	<1
	Change Farming Practices and Improve Yields		1	1		x	x		2.4	0	<1
	Optimise the Dairy Production Process		6	12	x	x	x		1.8 – 4.4	<1	2 – 3
	Reduce F-Gases and Use Lower GWP Alternatives		2	5	x		x	x	3.3 – 3.6	0	0
Switch to alternative modes of travel	Promote and Encourage Active Travel		87	214	x	x	x		1.3 – 3.3	1 – 3	6 – 15
	Enhance the Public Transport Offering		2	28	x	x			2.9 – 24	2 – 17	1 – 13
	Introduce Car and Ride Sharing Schemes		20	32	x	x			5.6 – 14.2	4 – 6	2 – 4
	Introduce Dynamic Tolling and Parking Fees for Motorised Vehicles		1	3	x	x	x		0.9 – 6	2 – 4	0 – 2
	Introduce a High-speed Electric Water-Taxi Service			15		x			3.9	-	3
Electrify and use renewable fuels	Use Electricity and Low-Carbon Fuels to Heat Residential Buildings	190	190	190	x			x	59.3	10	43
	Use Low Carbon Energy for Commercial &		203	203	x		x		26.2	10	43

	Industrial Buildings and Processes									
	Align with the UK's Jet Zero Strategy	N/A	N/A	N/A	x	x	x	9.8 – 13.7	-	-
	Use Alternate Fuels in Marine Vessels		40	42	x	x	x	x	3.2 – 11.3	-	9 – 10
	Encourage Electric Vehicle Adoption and Ban ICE Vehicle Imports	12	12	14	x	x	x	x	62.7 – 65.3	39 – 20	3 – 4
	Switch Existing Road Vehicles to using Renewable Fuels		0	0			x	x	3.3 – 0	0	0
Produce renewable electricity and fuels	Implement the Electricity Strategy and Increase Offshore Wind	530	530	580	x	x	x		23.3 – 24.9	12	47 – 51
	Produce Biofuels from Food and Agriculture Waste		10	10	x	x	x		0	2	2
	Introduce a Wastewater Treatment Plant with Anaerobic Digestion			90	x	x	x		2.9 (CCS)	7	29
	Produce BioLPG from Refuse and Biomass in a Gasification Plant			130	x	x	x		0	15	28
Enhance the natural environment and capture emissions	Improve soil management practices		1	1			x		1.2	0	<1
	Protect Woodland, Grassland and Biodiversity Levels	0	0	0	x		x		0	0	0
	Capture Carbon from Marine Vessels			3			x		0.6	0	<1
Engage and incentivise stakeholders	Communicate and Engage with Citizens and Businesses	N/A	N/A	N/A	x				0	-	-
	Leverage Incentives and Disincentives	N/A	N/A	N/A	x				0	-	-
Totals				**779 – 1740**					**199 – 288**	**67 – 125**	**118 – 336**

* Note that estimated carbon savings for each listed intervention is directly related to the identified investment. The total carbon savings for all interventions additionally includes carbon savings that are expected to occur regardless of investment.
** Energy savings are estimated maximums that can be achieved following the implementation of the applicable interventions, together with necessary adoption levels, and may change over time.

Achieving the Baseline pathway requires £779m of capital expenditure up to 2050, including already agreed policy decisions, and relates to implementation of the electricity strategy (£530m), expected energy efficiency and electrification of heating in residential buildings (£237m), and provision of infrastructure to support the expected uptake of electric road vehicles (£12m).

Achieving the Moderate pathway requires, over and above agreed policy decisions in the Baseline pathway, additional capital expenditure totalling £493m, which mainly relates to replacing fossil-fuel heating systems in business buildings (£203m), incentivising energy efficiency measures in residential and business buildings (£116m), re-designing roads to accommodate cycle routes (£87m), introducing infrastructure to enable maritime electrification and fuel switching (£46m), procuring Micro EV cars (£20m), and introducing a small renewable fuel plant (£10m).

Achieving the Ambitious pathway requires, over and above the Moderate pathway, additional capital expenditure totalling £469m, which mainly relates to scaling up local renewable fuel production and increasing offshore wind (£270m), scaling up the availability of shared bikes, buses and EV cars (£170m), and introducing a water taxi service with a fixed and frequent schedule from 2035 to reduce air travel within the Channel Islands (£15m). The Ambitious pathway also requires investment associated with residential and business buildings earlier in the timeline.

A direct comparison of indicative investment profile up to 2050 to achieve the Baseline, Moderate and Ambitious pathways is shown in Figure 25, using current monetary value and price levels. The presented investment levels broadly estimate capital expenditure in infrastructure and assets that may be considered publicly shared, and grants that the States of Guernsey might offer to incentivise citizens and businesses to encourage modal shifts or implement changes. Presented figures therefore do

include, for example, the cost of procuring shared bikes, buses and cars, however do not include, for example, costs that citizens and businesses will incur when purchasing their own electric vehicles or vessels. Additionally, full or differential costs associated with the purchase of existing or alternate fuels or electricity usage is not included.

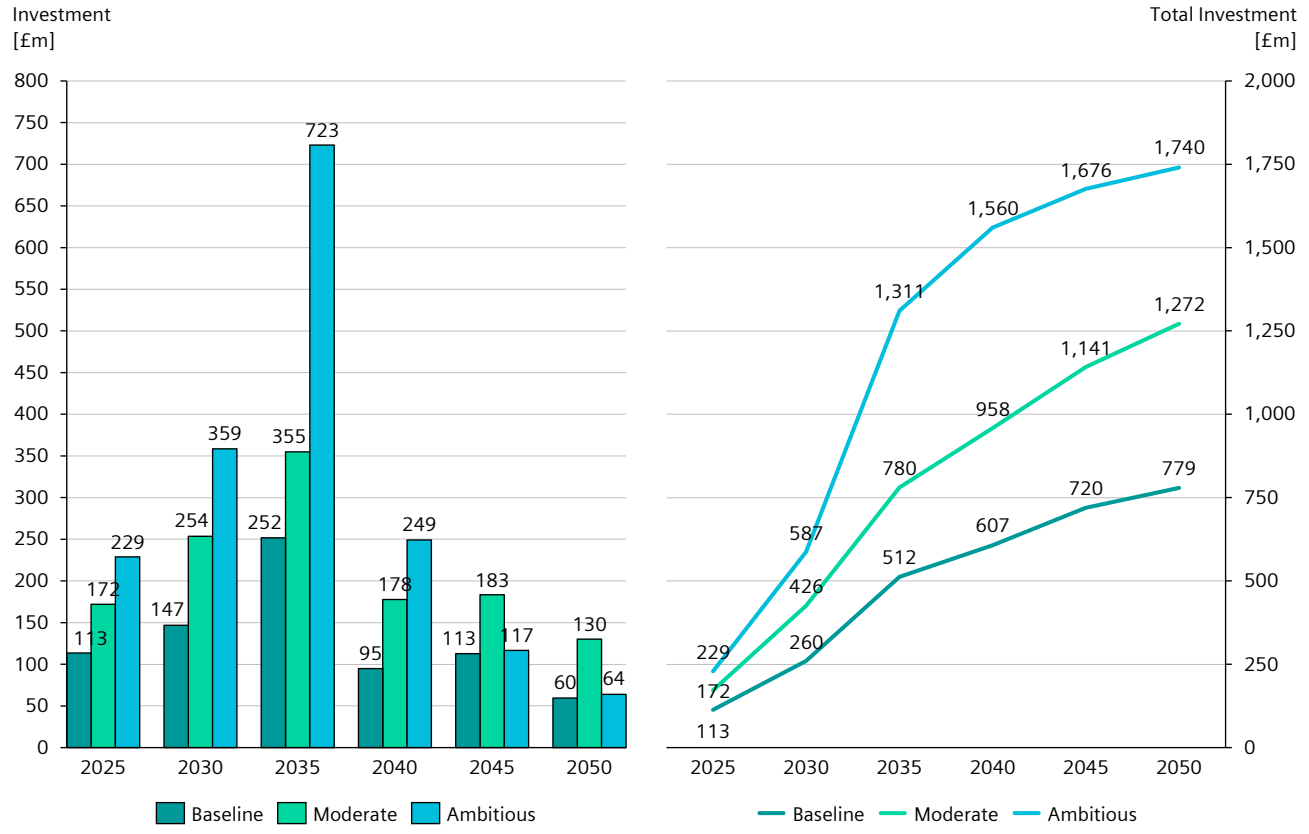


Figure 25: Investment per pathway up to 2050

The total investment presented for each pathway will require contributions from four groups. The States of Guernsey will need to provide publicly shared infrastructure and financial incentives or assistance to businesses and citizens. However, private investment from new or existing organisations can play a significant role in developing or enabling infrastructure projects, and establishing new businesses that could, for example, produce the alternative fuels and provide the active and shared transport services. Finally, individual businesses and citizens will make their own investments in relation to energy efficiency, electrification and switching to alternate fuels, much of which can be incorporated as part of a natural development, replacement and operation.

4.4 Benefits of the Decarbonisation Pathways

Decarbonisation will contribute significantly toward achieving the United Nation's seventeen (17) Sustainable Development Goals, as shown in Figure 7. Notably, this can contribute positively toward achieving good health and wellbeing (No. 3), clean water and sanitation (No. 6), affordable and clean energy (No. 7), decent work and economic growth (No. 8), industry, innovation and infrastructure (No. 9), sustainable communities (No. 11), responsible consumption and production (No. 12), climate action (No. 13), life below water and on land (Nos. 14, 15), and partnership for the goals (No. 17).

Investing in carbon reduction measures and reducing emissions will deliver numerous benefits to Guernsey's citizens, and this can be achieved in a manner that enhances Guernsey's lifestyle, character and economy. Citizens could expect to benefit from warmer (in winter) and cooler (in summer) buildings, lower energy costs, an improved range of options to travel in Guernsey with improved connections to neighbouring Channel Islands, new employment opportunities in most (if not all) sectors, and improvements to the local environment (air, land and water) that is beneficial to health and wellbeing.

By investing up to £779m for Baseline pathway interventions (or £249m plus £530m for implementation of the electricity strategy as an agreed policy decision), Guernsey could reduce its whole-Island energy spend by up to £67m each year, and add up to £118m each year to Guernsey's economy (GVA). Over the period of the Baseline pathway, this could result in up to £1,250m of energy savings and £2,200m of GVA for Guernsey's economy.

By investing up to £1,272m for Moderate pathway interventions (or £742m plus £530m for implementation of the electricity strategy as an agreed policy decision), Guernsey could significantly reduce its whole-Island energy spend by up to £99m each

year, and add up to £245m each year to Guernsey's economy (GVA). Over the period of the Moderate pathway, this could result in up to £1,670m of energy savings and £4,130m of GVA for Guernsey's economy.

By investing up to £1,740m for Ambitious pathway interventions (or £1,210m plus £530m for implementation of the electricity strategy as an agreed policy decision), Guernsey could even more significantly reduce its whole-Island energy spend by up to £125m each year, and add up to £336m each year to Guernsey's economy (GVA). Over the period of the Ambitious pathway, this could result in up to £2,230m of energy savings and £5,990m of GVA for Guernsey's economy.

Economic Growth: Transitioning to renewable energy sources and sustainable practices can create new economic opportunities in Guernsey. This can be achieved by investing in green technologies that create new jobs, encouraging businesses to develop their environmental action plans and report their performance, and attracting environmentally conscious businesses to locate in Guernsey. In connection with the developed pathways:

- As more consumers adopt electric vehicles and vessels, demand for related infrastructure such as charging stations and maintenance services will grow, which will provide growth opportunities for existing business and new start-ups, and result in skilled job vacancies to support increasing demand for product sales and associated installations and servicing.
- The need to implement and operate an EPC scheme across Guernsey's building stock and implement energy efficiency measures into existing residential and business buildings, as well as improving standards of new builds to meet net zero goals, will inform, educate and create opportunities in the construction sector.
- The need to introduce decarbonised heating solutions into Guernsey's existing residential and business building stock, and proposal to increase the level of offshore wind generation will create opportunities in the generation, distribution and retail segments of the electricity sector, and lead to an increase in consumer spending and skilled employment, and generate revenue from the export of higher levels of surplus offshore wind generation.
- The introduction of the proposed Anaerobic Digestion and Gasification plants would involve approximately 350 workers during its construction phase, comprised of approximately 125 local construction workers and 225 external contractors, and up to 150 workers would be required for ongoing operational roles.
- Given Guernsey's pre-eminent position and access to financial, insurance and professional services, additional economic growth could be anticipated from existing and newly domiciled investors and lenders. This could include facilitating and enabling Guernsey's energy transition and decarbonisation measures, as well as exporting green financing services to enable other jurisdictions to achieve their transition.

Energy Independence and Resilience: By relying less on fossil fuels and producing its own renewable fuels, together with full implementation of the electricity strategy, Guernsey can enhance its energy security and reduce vulnerability to price fluctuations or supply disruptions. In connection with the developed pathways:

- Increasing the level of offshore wind generation from 65 MW to 80 MW increases the level of electricity that is self-generated and increases the level of surplus electricity can be sold back or used as a flexible demand incentive.
- Locally producing bio-fuels will introduce a level of energy security from 2035, achieved by meeting up to 39% of residential and business gas needs and up to 97% of road and maritime transport fuel needs, and could mitigate against the risk of higher future costs associated with exporting and incinerating waste.

Health and Wellbeing: Increased levels of active travel and cleaner air resulting from reduced emissions can lead to improved public health, with fewer pollutants leading to lower rates of respiratory conditions and other health issues. In connection with the developed pathways:

- Providing a shared bike scheme that is widely and easily accessible, together with a network of walking and cycling routes with separation from motorised traffic, will encourage active travel and enable the local community to benefit from regular exercise that improves cardiovascular health, strengthens muscles, and supports mental wellbeing, and fosters social connections.
- Reducing emissions from all forms of motorised transports, together with decarbonisation of heating systems and electricity supply will result in cleaner air that improves respiratory health, reduces the risk of cardiovascular diseases, and enhances overall well-being.

Environmental Impact: By reducing greenhouse gas emissions, Guernsey can contribute to global efforts to combat climate change, whilst protecting its own environment, preserve biodiversity, and safeguard ecosystems. In connection with the developed pathways:

- Implementing the proposed Anaerobic Digestion and Gasification plants in Guernsey will mean that all waste will be treated locally instead of transporting it to other jurisdictions, and the anaerobic digestate derived from wastewater will be treated to a far higher environmental standard before discharging it to the sea.
- Using controlled released fertilisers with precision application on farms will reduce nitrate leaching into the water table and reducing soil compaction in fields and improve soil quality, which will promote improved water quality in surrounding water bodies and improve soil health.

- Encouraging the use of sailed and electric recreational vessels at marinas, together with the use of environmentally beneficial hull coatings that reduce drag and improved propulsion systems, offers the potential for reductions in water pollutants and noise levels that will benefit marine life below water.

Resilience to Climate Change: Implementing net zero interventions can simultaneously prepare Guernsey for potential climate impacts, and ensure that Guernsey is more resilient to extreme weather events, rising sea levels, and other consequences of global warming. In connection with the developed pathways:

- Improving soil management practices in connection with the agriculture sector, together with a possible increase in woodland coverage, can help regulate water flow, prevent soil erosion, and reduce the risk of flooding.
- Improving the performance of buildings, e.g. by increasing insulation levels, can protect occupants from extreme temperatures fluctuations.

Organisations will increasingly choose to locate in net-zero buildings and jurisdictions, and prioritise trade with partners that have acted positively on their own scope 1 and 2 emissions. For organisations and jurisdictions that do not act sufficiently on their emissions, they will become less resilient and competitive and may face increasing risks related to regulatory changes and reputational damage. For Guernsey, this could result in challenges for global economic trade, which would cause adverse impacts to the local economy.

4.5 Key Dependencies on achieving the Pathways

To achieve net zero, the most significant undertaking will be rapidly reducing the use of conventional fuels across all sectors, particularly in transport, residential, and business sectors, and key to achieving this lies in electrification, which additionally necessitates the decarbonisation of Guernsey's electricity supply. However, electrification is not the only answer. Reducing energy demand, improving energy efficiency and increasing the availability and adoption of renewable fuels also plays a positive role in reducing emissions, and can have a positive impact earlier in a decarbonisation pathway. The advantage of renewable fuels is that they emit up to 90% less CO_2e compared to conventional and can often be used in existing vehicles, vessels, aircraft, and even central heating systems, without the need for major modifications.

- **External (International):** Working towards and achieving net zero in most sectors will depend on the direction and progress of external jurisdictions, such as the UK and European Union, and particularly in relation to the import of goods that may continue to include, for example, internal combustion engines, conventional boilers, and use of F-gases. Additionally, and particularly in relation to aviation and marine travel, persuading airline and vessel owners to switch to electric and alternate fuels will depend on the neighbouring jurisdiction to have the necessary infrastructures and fuels.
- **Investment:** Implementing the interventions will require investment in every sectors, and achieving this will depend on businesses to invest in decarbonising their buildings, fleets and processes, and citizens to invest in decarbonising their homes and shifting away from private car use. Additionally, this will depend on attracting private investors that may further depend on (non) financial assistance and commitments from the public sector.
- **Technology:** Based on an expectation that almost half of the reductions in global emissions in 2050 will need to come from technologies that are currently at the demonstration or prototype phase, Guernsey will depend on major innovation efforts outside of its jurisdiction. For example, key areas will be the decarbonisation of aviation and marine vessels and travel, and capturing and utilising emissions.
- **Infrastructure:** Supporting growth in electrification and enabling a switching toward alternate fuels will depend on private organisations and public organisations to invest in areas such as electricity generation and distribution, wastewater treatment, renewable mains gas production and distribution, with associated storage, cabling, pipelines and access routes.
- **Spatial:** Constructing Wastewater Treatment, Anaerobic Digestion and Gasification plants, together with roads and pipelines will depend on the availability of land, which is a known constraint. Additionally, maintaining levels of carbon sequestration from Guernsey's natural environment will depend on achieving net migration and housing growth without adversely impacting levels of woodland, and allocating new land and marine environments for possible increases in sequestration levels.
- **Skills, Labour and Supply-chain:** The interventions will create opportunities for construction and operational roles, which will depend on developing and attracting skills and labour, together with support from third party providers that will need to be able to transport goods and provide services locally.
- **Stakeholders:** Achieving buy-in from citizens and businesses is a key dependency, which will result in everyone doing their bit to reduce consumption and waste, choose to make alternate choices (e.g., choice of heating and vehicles etc.), and change behaviours (e.g., mode of travel).

In connection with the interventions that contribute to reducing and/or offsetting emissions, Table 11 lists these key dependencies in more detail for the six decarbonisation themes.

Table 11: List of key dependencies to achieve the interventions in the developed pathways

Theme	Key Dependency
Increase efficiency levels and reduce demand	Introduction of IT systems for an EPC scheme and availability of labour to coordinate the scheme and carry out site visits
	Availability of funds for grants, with administration resources, to incentivise the introduction of energy efficiency measures
	Availability of materials and labour to retrofit energy efficiency measures in existing residential and commercial buildings
	Modification of docks and berths to accommodate newly introduced vessels, and support introduction of efficiency measures
	Availability of suitable agricultural equipment at no/low differential price compared to conventional alternatives
	Alignment with the UK on ambition and timeline for phasing out F-gases
Switch to alternative modes of travel	Alterations to roads, pavements and signage to provide safe cycle routes
	Allocation of spaces to install stationary bike racks and allocation of parking spaces for shared EV scheme
	Interest from service providers to introduce and operate bike and car sharing schemes
	Availability of space to construct depots and parking spaces for buses when not in use
	Availability of power supplies and charging infrastructure for zero emission buses
	Availability of labour to drive buses
	Configuration of IT system to enhance public transport charging scheme
	Use of connected cameras and sensors on street furniture and in vehicles to enable dynamic charging for journeys and parking
	Availability of a wet harbour and docks to enable the launch of a regular water taxi service between Channel Islands
	Availability of power supplies and charging infrastructure for electric water taxis
Electrify and use renewable fuels	Availability of labour to retrofit electric heating systems in existing residential and commercial buildings
	Availability of grants to remove the differential cost between low carbon heating systems compared to fossil-fuel alternatives
	Availability of labour to convert existing heating systems to using renewable fuels
	Availability of charging infrastructure at airports for use by private aircraft, service vehicles and operational equipment
	Reconditioning of existing (possibly new) storage tanks at the airport for Sustainable Aviation Fuels used in commercial aircraft
	Availability of charging infrastructure at port and marinas for use by commercial and recreational vessels, service vehicles and operational equipment
	Reconditioning of existing (possibly new) storage tanks at seaport and marinas for Biomethane used in vessels
	Reconditioning of existing storage tanks at fuel forecourts for Biomethane used in road vehicles
	Adequate of private EV chargers in residential and commercial settings, and availability of public EV charging
	Availability of imported renewable fuels at no/low differential price compared to using conventional fuels
Produce renewable electricity and fuels	Allocation of space at Longue Hougue for construction of an AD plant (food, agriculture) and Gasification (RDF, Biomass)
	Allocation of space at Belle Greve for construction of a water treatment works with AD facility (wastewater)
	Allocation of space at Longue Hougue for construction of a Gasification plan (RDF waste, Biomass)

	Consenting of access routes into the AD and Gasification plants
	Availability of electricity grid connections to the AD and Gasification plants, and gas grid connection for the Gasification plant
	Availability of landfill for hazardous waste from a local Gasification plant
	Availability of labour to construct and operate AD and Gasification plants
Utilise and enhance the natural environment	Housing growth delivered without reducing levels of woodland (note replacement woodland will have a time lag)
	Existence of supply-chain to procure and import alternative fertilizers
	Availability of labour and specialist equipment to achieve sequestration and biodiversity projects
Engage and incentivise stakeholders	Availability of funds to facilitate and enable the incentives and interventions within the developed pathways
	Approval of sources of finance from investors and lenders, and income from duties, charges and taxation
	Cooperation from citizens and businesses on the need to act

4.6 Cumulative Greenhouse Gas Emissions of the Pathways

In addition to identifying interventions which could contribute to reaching net zero by 2050, it is important to consider the cumulative impact of emissions in the interim years. For the developed pathways, Figure 26 shows a direct comparison of cumulative emissions and the level of emissions at five-yearly intervals. Compared to the Baseline pathway, which generates 5,469 $ktCO_2e$ of emissions up to 2050, enacting the Moderate pathway would reduce cumulative emissions by 22% and enacting the Ambitious pathway would reduce cumulative emissions by 39%.

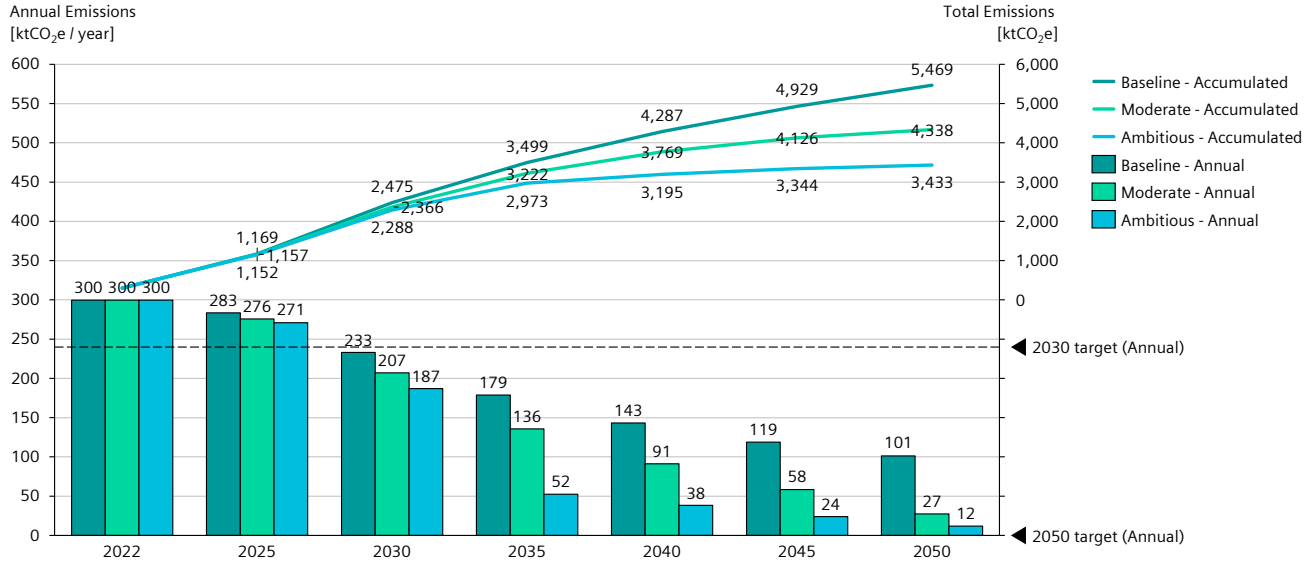


Figure 26: Emission estimates under the Baseline, Moderate, and Ambitious pathways, 2022 - 2050

The reduced level of cumulative emissions in the Moderate pathway, compared to the Baseline pathway, is achieved by:

- Implementing electric heating in business buildings and for industrial processes.
- Encouraging electric marine vessel adoption and switching existing vessels to using renewable fuels.
- Making available alternative modes of travel and transportation.
- Encouraging new farming practices to increase yields from reduced cattle herds.
- Implementing energy efficiency measures into existing residential and business buildings.
- Importing only renewable fuels from 2050.

The reduced level of cumulative emissions in the Ambitious pathway, compared to the Moderate pathway, is achieved by:

- Encouraging on-Island travel from motorised vehicles to active modes of travel.
- Replacing flights with electric water taxis for travel between Guernsey and Channel Islands.
- Increasing and accelerating levels of energy efficiency and electrification in residential and business buildings.
- Establishing large-scale local fuel production using wastewater and solid waste to offset emissions.
- Increasing the sizing of offshore wind generation.
- Importing only renewable fuels from 2035.

DECARBONISATION PATHWAY OPTIONS FOR THE ISLAND OF GUERNSEY

5.0 Initiatives to Enact the Decarbonisation Pathways

To achieve the Baseline, Moderate and Ambitious pathways, the timely implementation and adoption of carbon reduction and offsetting interventions are required. In this section of the report, a total of twenty-four (24) decarbonisation interventions, grouped into six (6) cross-sector themes, aim to reduce and/or offset Guernsey's Scope 1 and 2 emissions across all eight (8) sectors that are presented in the three (3) differing pathway options.

By grouping the interventions for the Moderate and Ambitious pathways into themes, benefits from several sectors can be linked and extracted to create new opportunities. To assess the additional benefits - beyond GHG emission reductions - the UN's SDG framework mentioned in section 2.2 was used. As well as reducing or offsetting emissions, the interventions in all pathways would contribute toward some of the UN's Sustainable Development Goals, most notably good health and wellbeing (No. 3), clean water and sanitation (No. 6), affordable and clean energy (No. 7), decent work and economic growth (No. 8), industry, innovation and infrastructure (No. 9), sustainable communities (No. 11), responsible consumption and production (No. 12), climate action (No. 13), life below water and on land (Nos. 14, 15), and partnership for the goals (No. 17).

For every intervention, its intended purpose is outlined, together with associated key assumptions that are applied in the pathways, and anticipated outcomes that could be expected following its successful implementation. Interventions also include high-level indicators, which seek to provide direct comparisons with regards to carbon savings, investment levels, and cost savings. Notably three indicators are used to determine maturity, complexity and acceptance:

- **Maturity:** Describes the market-readiness and availability of an intervention and its associated technologies. It considers the quality and quantity of the supply chain required and how well-established associated technologies are.
- **Complexity:** Describes the difficulty implementing and operating an intervention with its associated impact on budget and project schedules. It is based on Helmsman Complexity Scale[48] and takes into consideration the number of interdependencies, including the development of skills and expertise.
- **Acceptance:** Describes the population's anticipated perception of a particular intervention and whether it is likely to be controversial or popular. Responses to the Island Global Research's survey on Changing Energy Behaviour[49] were considered, where appropriate.

Figure 27 provides a visual representation of the key actions and milestones associated with the implementation and adoption of the interventions, which are mapped to the cross-sector themes and indicative timelines.

[48] Helmsman Guide to Complexity Scale
[49] Island Global Research – Changing Energy Behaviour – March 2020

Increase efficiency levels and reduce demand

2025
- All new homes from 2025 built to the UK's Future Homes Standard
- Energy certificate schemes introduced for existing buildings
- Heat load efficiency in buildings increases by 21% up to 2050

2030
- Demand for dairy products reduces by 20% up to 2030
- Demand for dairy products reduces by 50% up to 2030
- UK F-Gas Regulation cuts HFC quotas by 79% between 2015 and 2030

2035
- Locally produced biomethane available
- Heating systems use renewable fuels from 2035
- Dairy herd reduced by 12%

2040
- 97% of homes and 95% of commercial buildings with energy efficiency measures
- Maritime fuel demand reduces by 23%
- Improved cattle nutrition and health, and slurry treatments

2050
- 97% of homes and 95% of commercial buildings with energy efficiency measures
- Improve fuel efficiency by 10% in maritime transport
- Maritime fuel demand reduces by 23%
- Dairy herd reduced by 19%
- F-gas emissions reduced
  - 70%
  - 79%
  - 88%

Switch to alternative modes of travel

2025
- 5% of total passenger mileage by active travel and remains constant over time

2030
- Car parking charges introduced
- Improved and subsidised public transport available
- Active and shared transport schemes expanded to meet growing demand
- Flights to Channel Islands switch to electrified water taxis

2035
- 500 shared bikes available from 50 hub locations
- 1,000 shared e-bikes available from 75 hub locations
- Free of charge flexible public transport available
- 500 shared EV microcars available
- 1,000 shared EV microcars available
- Tolls introduced for single-occupied car journeys

2050
- 20% of road network with safe priority cycling
- 50% of road network with safe priority cycling
- On-demand travel service available from 100 vehicles
- On-demand travel service available from 1,000 vehicles

Electrify and use renewable fuels

2025
- Vessel emissions continue to increase in line with population

2030
- Maritime electrification and renewable fuel switching commences
- Ammonia introduced for maritime vessels
- Ban on new ICE vehicles introduced

2035
- 50% of fuel oil and 20% of gas oil vessels switch to using biofuels or ammonia
- All non-electric vessels switch to using biofuels or ammonia
- Ban on new ICE vehicles introduced
- Ban on the import and use of all conventional fuels

2040
- 90% of homes with electric heating and the remaining 10% use renewable fuels
- 90% of C&I heating systems and processes are electrified, and remaining systems and processes use renewable fuels
- Phase out remaining ICE vehicles

2045
- 90% of C&I heating systems and processes are electrified

2050
- 90% of homes with electric heating
- Remaining 10% of homes use renewable fuels
- SAF
  - 10%
  - 50%
  - 100%
- EVs
  - 95%
  - 99%
- 25% of vessels with electric engines
- Ban on the use and import of all conventional fuels

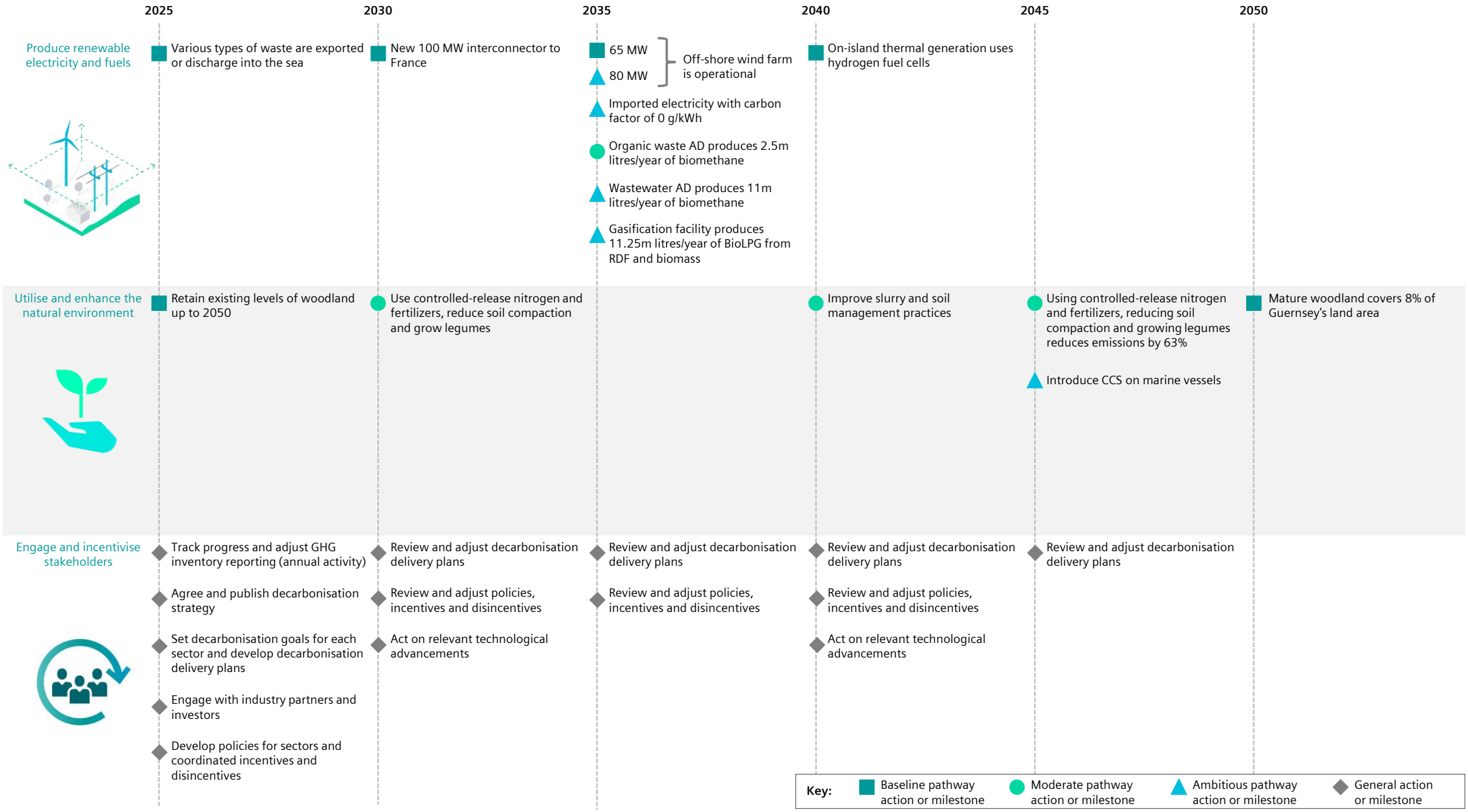


Figure 27: Visual roadmap actions and milestones to achieve the Baseline, Moderate and Ambitious pathways

For each cross-sector theme, interventions are each set out below in a 2-page format. Note that the second page of each intervention includes a high-level list of suggested actions and action owners, and the action are intended for the general implementation of the intervention, irrespective of which pathway (or pathways) it is applicable to.

5.1 Theme 1: Increase efficiency levels and reduce demand

This theme includes several interventions with a focus on improving the efficiency of existing buildings and replacing refrigerants, updating aircraft and sea vessel fleets, and improving dairy yields.

T1.1: Increase energy efficiency of residential buildings using energy certifications

T1.2: Increase energy efficiency of commercial & industrial buildings and processes

T1.3: Improve the efficiency of marine vessels

T1.4: Change farming practices and improve yields

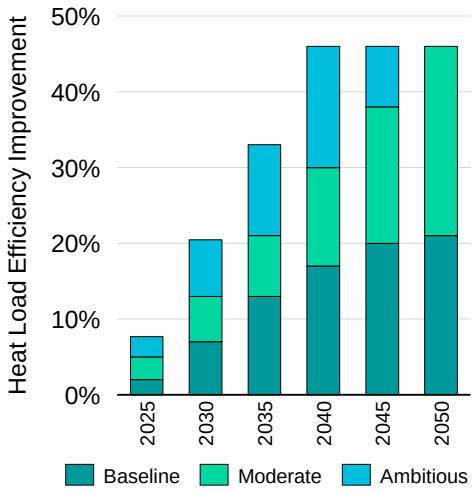
T1.5: Optimise the Dairy production process

T1.6: Reduce F-gases and use lower Global Warming Potentials (GWP) alternatives

T1.1 Increase Energy Efficiency of Residential Buildings using Energy Certifications

There is significant potential to increase the energy performance of existing and new residential buildings in Guernsey. This can be achieved by assessing the energy efficiency level of the existing building stock, introducing minimum energy efficiency standards for rental properties, new builds and extensions, and introducing an energy certificate scheme to provide visibility to prospective purchasers and tenants, and encourage improvements.

Decarbonisation Pathways & Timeline



Baseline: By 2050, the building stock's heat load efficiency increases by 21%, as outlined in the Electricity Strategy.

Moderate: By 2050, 97% of existing rental and private homes are retrofitted with impactful fabric and energy efficiency measures, and all new homes from 2025 onwards are built to the UK's Future Homes Standard, which increases the heat load efficiency to 46%. The introduction of an energy certificate scheme with CO_2e impact would assess the current state of the residential building stock and monitor its evolution.

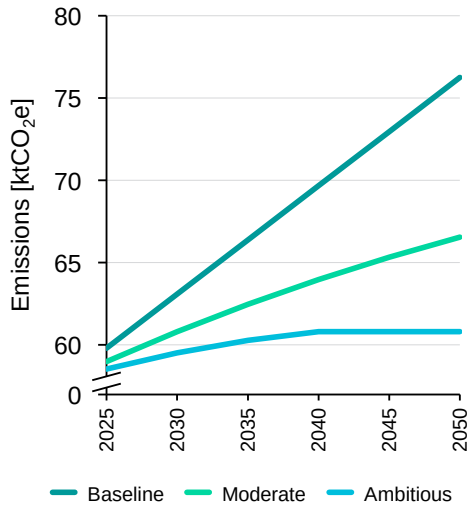
Ambitious: Intervention and results in the Moderate pathway achieved ten years earlier, by 2040.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**High**	**1.1 – 1.4** tCO2e/building	**5 – 9** £/kgCO2e	**25 – 38** £m/year

Considerations & Constraints

Energy efficiency measures may encompass insulation, airtightness, ventilation, solar shading, window and door upgrades, low-energy heating and lighting, and smart controls. An energy certificate scheme will require a comprehensive building stock audit and assessor training. Systems will be required to capture and manage audit data, and future changes. Minimum building standards may be mandated for all rental properties and new-builds, and required when giving consents for extensions/improvements. For existing private homes, education and the provision of general or means-tested financial assistance will be required.

Outcomes & Benefits



Up to 15 $ktCO_2e$ of annual emissions can be saved by implementing distributed building stock improvement measures.

22% reduction in CO_2e

Energy efficiency measures also promote better living conditions through improved indoor microclimates, which lead to health benefits.

Health & Wellbeing benefits

The scale of this intervention enables significant market growth in the building sector and job creation.

Job creation

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Building Stock Audit	Conduct a building stock audit to identify clusters of high energy demand.	Development and Planning Authority (DPA)
B – Review and update building regulations	Benchmark current regulations against international best practice, particularly for similar climates and economies, and scientific best practice, e.g. Passivhaus Premium.	Development and Planning Authority (DPA)
C – Legislate for EPCs or 'Building Passports'	Introduce legislation to ensure the building stock audit is further enhanced with energy certificates for buildings at significant milestones, such as major renovation works, resales or renewal of rental agreements. As an energy certificate scheme is currently being considered, ensure best practice is adopted, which may include use of 'building passports' (a live document and data-set covering all aspects of a building).	States of Guernsey
D – Explore Finance Scheme	Assess the benefits of providing 'green finance' to accelerate this transition and to support homeowners with upfront investments.	Policy and Resources
E – Review Progress	Create a mechanism to regularly review the building stock performance and adjust strategic action accordingly, including labour market action, financial incentives and asset valuation disincentives.	States of Guernsey

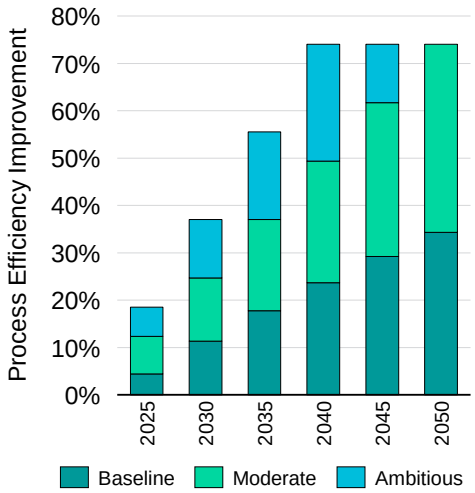
Alignment with UN's Sustainable Development Goals

Good Health & Well-being (SDG 3), Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13)

T1.2 Increase Energy Efficiency of Commercial & Industrial Buildings and Processes

Introduce an energy certification scheme to provide building tenants with visibility of building energy efficiency and CO_2e levels, and require organisations to periodically, such as every 3-5 years, audit their energy uses (e.g., buildings, processes, equipment) to identify tailored and cost-effective measures to save energy and achieve carbon and cost savings, and which organisations are then required to implement.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented, however a natural transition to more efficient boilers and heating systems was assumed at annual rates of 1.4% for kerosene and 2% for gas oil consumption.

Moderate: By 2050, 95% of commercial and industrial buildings are retrofitted and systems replaced or introduced, which increases the overall efficiency of the commercial and industrial building stock by 40%.

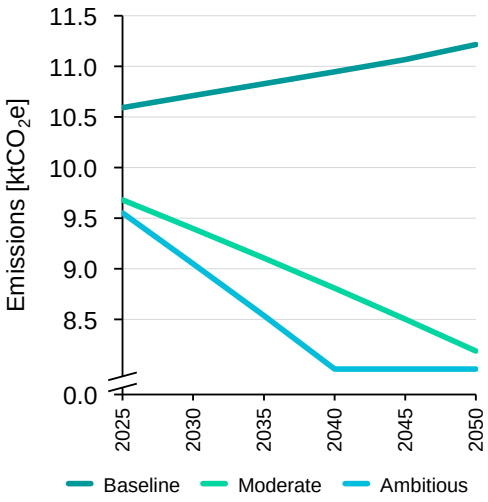
Ambitious: Retrofitting and efficiency levels in the Moderate pathway achieved ten (10) years earlier by 2040.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**High**	**3.1 – 3.7** $kgCO_2e/m^2$	**37 – 40** £k/$kgCO_2e$	**43 – 53** £m/year

Considerations & Constraints

An energy assessment scheme will encourage building owners to implement retrofit measures, particularly as tenants will increasingly demand energy efficient buildings as part of their net zero goals and plans. Energy efficiency measures may encompass passive types, such as insulation and replacing inefficient equipment and appliances, and active ones, such as building management systems and operational behavioural changes. The periodic audit costs are estimated to be significantly outweighed by the savings from implementing the recommendations. Expenditure (above) includes insulation, intelligent energy management system and labour costs. Additional project costs include preparatory work (audit) and energy assessment deployment.

Outcomes & Benefits



Implementing energy improvement measures alone in the business sector can reduce emissions by 3 $ktCO_2e$.

Improved condition and efficiency of buildings attracts tenants at higher rents.

Reduces energy consumption and bills, and positively contributes to achieving ESG goals.

Improves the working environment, which promotes workplace creativity and productivity, and wellbeing of staff.

29% reduction in CO_2e

Energy efficient buildings

Sustainable and ethical business

Productive workplaces

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Engagement and early adoption	Establish a focus group of businesses with the highest energy demand and consumption, and commitment to pioneering energy retrofits. Adopt energy efficiency related regulations e.g., energy rates, energy performance certificates, building codes for new buildings etc. Together with stakeholders, create action plan in line with energy status findings and regulations.	States of Guernsey
B – Pilot projects and proof points	Establish agreements with businesses to pilot retrofit initiatives and ensure that applicable planning permissions and building control approvals are issued where necessary. Evaluate pilot projects in relation to the objectives of decarbonization strategy compliance and solicit feedback from businesses.	States of Guernsey with engagement from businesses and support from Planning
C – Scale up	Expand retrofit via 'fabric first' approach and implementation of active measures for industrial processes e.g., intelligent energy management systems to measure, monitor, optimize and automate. Introduce incentives to encourage adoption if needed. Trace the speed of implementation and the outcomes. Adjust agreements terms, together with incentives and disincentives, if needed.	Businesses with monitoring by States of Guernsey
D – Monitor and adjust	Keep initiative up-to-date by cooperating with businesses, investors and other partners.	States of Guernsey

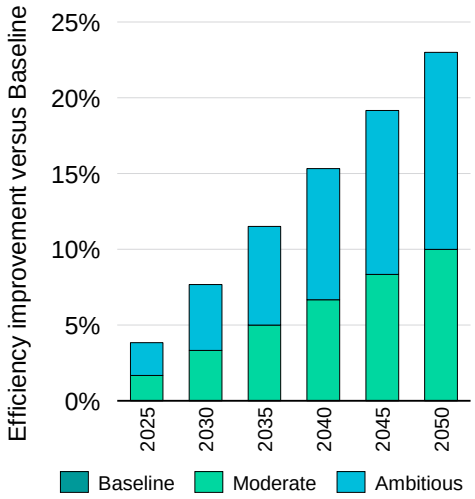
Alignment with UN's Sustainable Development Goals

Good Health & Well-being (SDG 3), Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13)

T1.3 Improve the Efficiency of Marine Vessels

This intervention covers fuel efficiency improvements, resulting in less fuel required to power marine vessels. Fuel efficiency improvements can occur through optimising ship design and hull coatings to reduce drag, improving propulsion systems and engines, reducing vessel speed and optimising route selection.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented.

Moderate: By 2050, a 10% reduction in fuel demand compared to the Baseline pathway is assumed due to efficiency gains from a range of improvements.

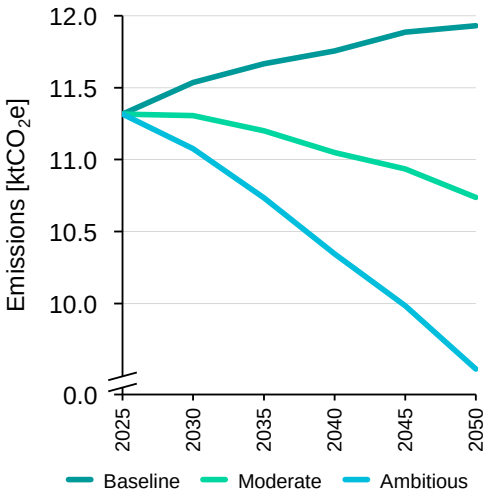
Ambitious: By 2050, a 23% reduction in fuel demand compared to the Baseline pathway is assumed due to efficiency gains from a range of improvements, such as fleet turnover and use of hydro foiling.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Medium**	**High**	**1.2 – 2.4** ktCO₂e/year	**18 – 34** £/kgCO₂e	**<1** £m/year

Considerations & Constraints

One of the biggest concerns for vessel owners will be cost and incentives and/or regulation will be necessary to implement this intervention. An incremental approach, rather than wholesale change, will best achieve cooperation and active participation from private vessel owners. Training will be needed to develop a workforce to implement and maintain the efficiency solutions and realise their potential benefits. Quoted expenditure and cost savings figures are based on the CCC's cost figures, emission reduction opportunities are applied to the GHG inventory to derive an equivalent for Guernsey.

Outcomes & Benefits



Increasing the efficiency of marine vessels can reduce GHG emissions by up to 2 ktCO₂e.

Increased fuel efficiency reduces operational costs and increased the lifespan of vessel components.

Reducing emissions of some harmful air pollutants, as well as potentially reducing pollutants will benefit marine wildlife and marine biodiversity.

10% reduction in CO_2e

Improved air quality

Reduce noise levels

Reduced pollution

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Monitor technology trends and markets	Any regulatory or fiscal measures to encourage greater vessel efficiency will need to be in line with market trends.	States of Guernsey supported by Guernsey Harbours
B – Regulatory and/or fiscal measures to encourage uptake of efficient vessels	Identify the most appropriate measure or combination of measures for incentivising more efficient vessels.	States of Guernsey
C – Engagement with vessel owners	Information, advice and training provided to vessel owners on potential efficiency improvements. Raise awareness in the industry more generally on environmental issues and marine users' responsibilities.	Guernsey Harbours
D – Training of people to work in this area	Support the training of workers to install and maintain technology for more efficient vessels. Also consider bringing this expertise in from elsewhere to supplement local training.	Guernsey Harbours

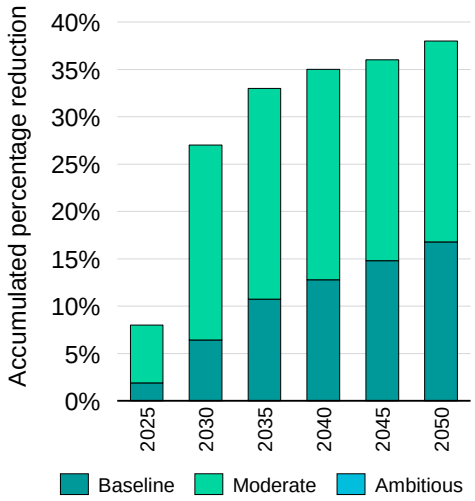
Alignment with UN's Sustainable Development Goals

Good Health & Well-being (SDG 3), Decent Work & Economic Growth (SDG 8), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life Below Water (SDG 14)

T1.4 Change Farming Practices and Improve Yields

This intervention represents a combination of adjustments to farming practices in Guernsey, which will reduce the amount of methane (CH4) and nitrous oxides (N2O) released to atmosphere from cattle and sheep. The combination of proposed interventions were taken from the WWF's 2019 report, Delivering on Net Zero: Scottish Agriculture.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented.

Moderate: Range of interventions includes improvements to ruminant nutrition and improving sheep and cattle health. For cattle, this intervention also includes implementing high fat diets, use of nitrate and 3NOP feed additives, and slurry acidification / aeration. Techniques are applied in overlapping phases, with a 26% reduction in emissions achieved by 2039.

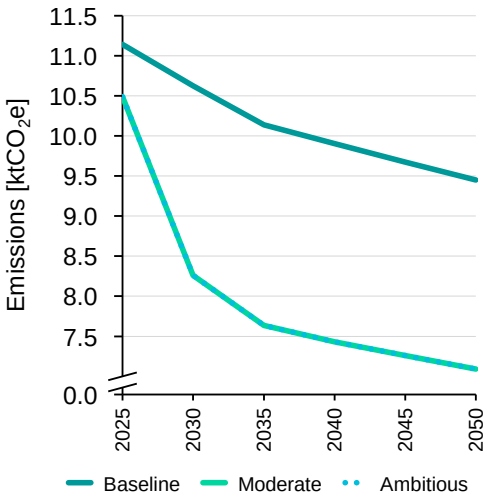
Ambitious: No additional measures are implemented compared to the Moderate pathway, as shown on the graph.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Medium**	**Medium**	**0.5 – 2.1** ktCO$_2$e/year	**0.1 – 0.2** £/kgCO$_2$e	**<1** £m/year

Considerations & Constraints

Drivers for action on farming practices include financial-, yield- and productivity gains, availability of incentives, farm assurance schemes, and consumer demand and policy demands relating to animal welfare. Similarly, barriers to action include upfront investment and ongoing costs, technical knowledge and skills. Therefore, payments or incentives may be required to support farmers moving towards innovative or alternative practices, together with provision of advice and training. Attention will need to be given to establishing processes for monitoring and evaluation, and environmental auditing.

Outcomes & Benefits



Improved nutrition and feed additives reduces emissions from livestock, and reductions in ammonia emissions also contribute to air quality.

Improved productivity gained through low emission practices could also offer financial benefits.

A key component of improved productivity is improving livestock health, which results in improved reproductive performance and reduced mortality levels.

26% reduction in CO_2e

Efficiency gains and financial savings

Improved livestock health

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Engagement with farmers and landowners	Engage with farmers and landowners to where new practices could be implemented and the potential scale of improvement. Also to assess current capabilities for implementing changes to practices and identify training and advice requirements.	States of Guernsey with support from research organisations
B – Regulation/fiscal measure to reduce N input	Identify and implement the most appropriate measures for encouraging the move to low emission practices.	States of Guernsey
C – Training of farmers and landowners	Provide advice and training to farmers on low emission farming practices. Support farmers in implementing these practices.	States of Guernsey with support from research organisations
D – Establish monitoring mechanisms	Establish a process for analysing and monitoring progress.	States of Guernsey with support from appointed third-parties and support from Farmers' unions

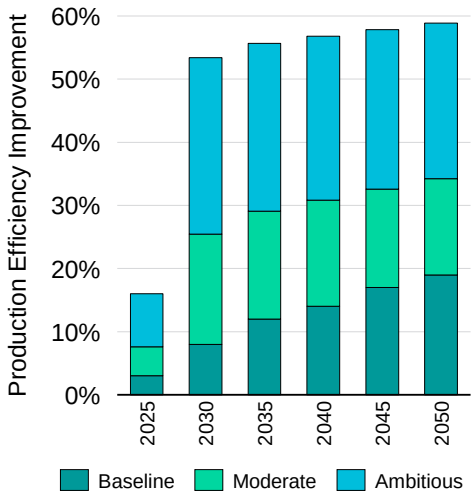
Alignment with UN's Sustainable Development Goals

Zero Hunger (SDG 2), Good Health & Well-being (SDG 3), Clean Water & Sanitation (SDG 6), Responsible Consumption & Production (SDG 12), Life on Land (SDG 15)

T1.5 Optimise the Dairy Production Process

Guernsey meets its dairy requirements and is an exporter of Guernsey butter to the UK, which involves approximately 1,500 cattle. Through improvements such as diet improvement programmes and robotic milking systems, milk yield per head of cattle can be increased, which will require a smaller herd to meet the same or reducing level of demand. Included in this intervention is an assumed reduction in demand in dairy products up to 2050.

Decarbonisation Pathways & Timeline



Baseline: Reduced dairy cattle herd due to production efficiency improvements. Assumed 1% annual reduction between 2023 and 2035, and 0.5% annual reduction up to 2050.

Moderate: Alignment to the CCC's Balanced Net Zero Pathway, which suggests that global dairy product demand could reduce by 20% up to 2030, or level of emissions reduced by improvements to production yields.

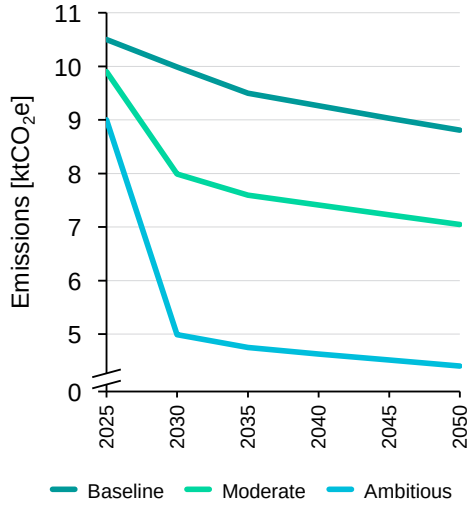
Ambitious: Alignment to the CCC's Tailwinds scenario, which suggests that global dairy product demand could reduce by 50% up to 2030, or level of emissions reduced by improvements to production yields.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Medium**	**Low**	**1.8 – 4.4** ktCO₂e/year	**2.7 – 3.4** £/kgCO₂e	**2 – 3** £m/year

Considerations & Constraints

This is not an intervention that encourages reduced dairy demand. Improving production yields necessitates ensuring that selected breeds are best suited to the local climate and have resistance to common diseases, adopting nutrient-rich feeding programmes, making available well-designed barns with proper ventilation and insulation and adequate space to improve cattle health and wellbeing, providing regular veterinary care and disease prevention protocols, and using technologies, such as automated feeding systems, monitoring devices and data analytics improve record keeping and decision-making.

Outcomes & Benefits



Meeting Guernsey's demand for dairy products from smaller and more productive herds will reduce emissions in the agriculture sector by up to 4 ktCO₂e.

50% reduction in CO₂e

Introducing production improvement interventions can be highly beneficial to the health and wellbeing of cattle.

Livestock health and wellbeing

Efficient production of dairy products can also contribute to product and brand quality.

Product and brand quality

Associated Actions & Responsibilities

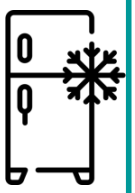
Action	Objectives	Responsibility
A – Conduct research on the drivers and variables for dairy consumption	Conduct research relating to local behaviour change to identify the key drivers locally and in export markets relating to dairy consumption. This will help to establish trends in future demand and influence long range business planning.	States of Guernsey supported by research organisation
B – Devise and implement an education campaign related to dairy consumption	Provide education and training to farmers on future dairy consumption and demand, together with opportunities to introduce production improvements	Guernsey Dairy supported by research organisation
C- Consider dairy production opportunities	Consider dairy production opportunities, which might include adopting nutrient-rich feeding programmes, investing in well-designed barns with proper ventilation and insulation and adequate space to improve cattle health and wellbeing, changing veterinary care strategies and schedules, and using technologies, such as automated feeding systems, monitoring devices and data analytics improve record keeping and decision-making.	Guernsey Dairy and Farmers facilitated by States of Guernsey

Alignment with UN's Sustainable Development Goals

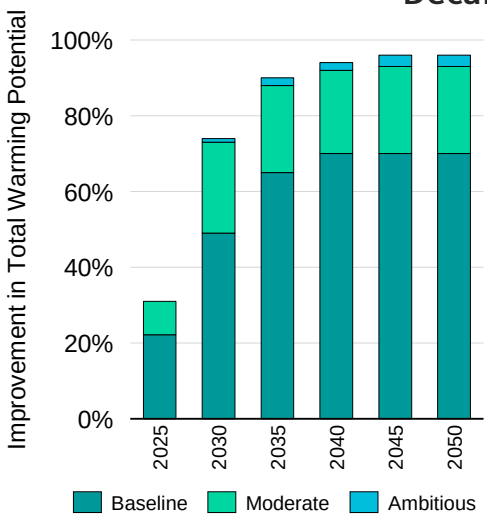
Zero Hunger (SDG 2), Industry, Innovation & Infrastructure (SDG 9), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15)

T1.6 Reduce F-Gases and Use Lower GWP Alternatives

F-gases are greenhouse gases containing fluorine and have a range of Global Warming Potentials (GWPs) that are more potent than CO_2. This intervention requires an uptake of Dry Powder Inhalers (DPIs) by GPs and patients instead of using Metered Dose Inhalers (MDI), and technology improvements that include lower leakage rates of refrigerants and use of lower-GWP alternatives in small retail condensing units, small industrial sites and in marine industries.



Decarbonisation Pathways & Timeline



Baseline: Implementation of UK F-Gas Regulation steadily reduces the quota of HFCs available on the market to reach a 79% reduction between 2015 and 2030. Based on lower leakage rates and lower GWP alternatives, emissions reduce by 70% between 2022 and 2050. It is assumed that UK appliances using these f-gases are imported to Guernsey.

Moderate: Increased use of DPIs over MDIs leading to a 79% reduction in f-gas emissions by 2050.

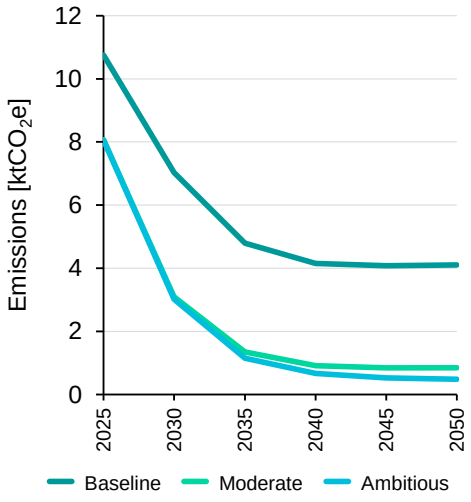
Ambitious: Additional DPI uptake compared to the Moderate pathway and HFC-32 switched to a lower GWP-alternative, leading to an 88% reduction in f-gas emissions by 2050.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Medium**	**High**	**3.2 – 3.6** ktCO2e/year	**0.5 – 1.2** £/kgCO2e	**N/A** £m/year

Considerations & Constraints

With most products using f-gases being imported, Guernsey will be heavily reliant on changes occurring at a broader scale, such as in the UK, or the EU, if imported from France. Therefore, Guernsey will have little control over the timing and level of ambition for this action as trying to introduce more stringent action could result in a lack of supply or unfeasibly high prices. Quoted expenditure and cost savings figures are the CCC's 2026 additional investment and operational costs, scaled by emissions to derive an equivalent for Guernsey. 2026 was used as this is start of the next phase of the intervention.

Outcomes & Benefits



With an uptake of Dry Powder Inhalers (DPIs) by GPs and patients instead or using metered dose inhalers (MDI), and technology improvements, emissions associated with f-gases could reduce by up to 4 ktCO2e.

Due to Guernsey's scale, it has the opportunity to be a global leader in accelerating the removal of f-gas products from its markets.

88% reduction in CO_2e

Thought leadership

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Identify and monitor market trends	Ensure Guernsey regulation is in line with UK and, if applicable, EU markets.	States of Guernsey
B – Audit supply chain	Review all products with F-gas content that enter the Island and identify clusters and alternatives	States of Guernsey
C – Consider Regulatory Incentives	Explore the option to create dedicated incentives / disincentives, e.g. in the form of taxes or rebates, to encourage the uptake of lower GWP alternatives, including in residential and business settings	States of Guernsey
D – Encourage use of DPIs	Consult with GPs and, with their support, encourage GPs to prescribe Dry Powder Inhalers (DPIs) instead of Metered Dose Inhalers (MDIs).	States of Guernsey with support of local health departments

Alignment with UN's Sustainable Development Goals

Industry, Innovation & Infrastructure (SDG 9), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Partnerships for the Goals (SDG 17)

5.2 Theme 2: Switch to alternative modes of travel

This theme includes several interventions with a focus on introducing bike and car sharing schemes at scale to reduce car ownership and traffic levels, and substituting short-distance flights with high-speed electric water taxis between Guernsey and Channel Islands.

T2.1: Promote and encourage active travel

T2.2: Enhance the public transport offering

T2.3: Introduce car and ride sharing schemes

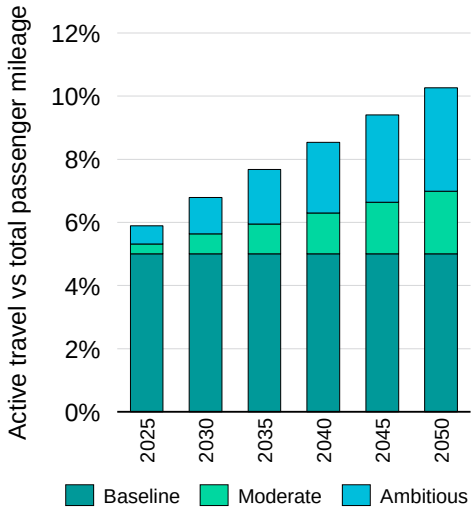
T2.4: Introduce dynamic tolling and parking fees for motorised vehicles

T2.5: Introduce a high-speed electric water-taxi service for Channel Islands travel

T2.1 Promote and Encourage Active Travel

The aim of promoting and motivating the uptake of active travel is to enable a modal switch away from powered vehicles by proving a comfortable and safe environment for walking and cycling. The intervention consist of several elements, such as cycling infrastructure (cycling lanes, bicycle sharing schemes, travel hubs with secure lockers and bicycle parking) as well as school & commuter initiatives.

Decarbonisation Pathways & Timeline



Baseline: 5% of total passenger mileage assumed to be active travel and assumed to be constant over time.

Moderate: By 2035: 500 sharing bikes are located across 50 hubs and used twice a day to travel 4km in total; 50% of schools offer active travel support at least twice a week; by 2050: cycling lanes or a priority scheme for cyclists is implemented on 20% of the road network

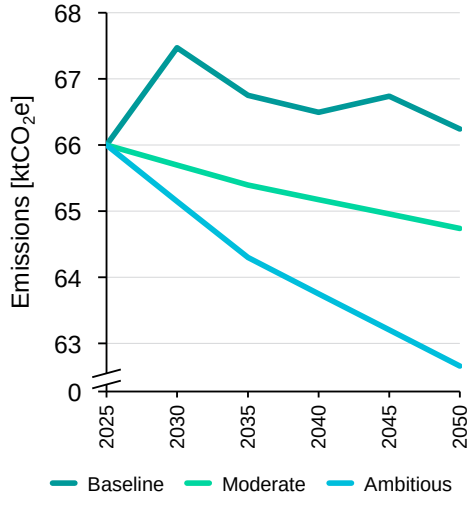
Ambitious: By 2035: 1000 sharing e-bikes are spread across 75 hubs and used 4 times a day to travel 8km in total; 50% of schools and businesses offer active travel support every day - roads are closed for cars for 1hour in the morning and in the afternoon to allow safe walking and cycling; by 2050: cycling lanes or a priority scheme for cyclists is implemented on 50% of the road network.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**High**	**3.8 – 7.3** gCO_2e/km	**2.2 – 2.8** $£/kgCO_2e$	**6 – 15** £m/year

Considerations & Constraints

The implementation of physically cycle lanes, mixed or segregated, requires the most significant expenditure of this intervention (ca. £500k – 800k per km) along with the acquisition of bicycles and stations (ca. £13k per bicycle). However, the active travel school & commuter schemes require no capital investment, provided operational spending is allocated to safety training and bicycle checks. In addition, an element of societal change is required to ensure active travel becomes a life-style, which could be done via car-free festivals to provide great experiences of the city and neighbourhoods in a car free setting.

Outcomes & Benefits



Shifting car travel to active travel reduces the direct emissions of fuel combustion by up to 3.2 $ktCO_2e$ by 2050.

>5% reduction in CO_2e

Active travel promotes a healthier lifestyle, reducing the risk of obesity and cardiovascular diseases, amongst others; whilst also reducing inequalities with regards to access to transport and status.

Health & well-being effects

Transitioning to active travel also reduce the electricity demand of up to 3000 cars and with it the amount of EV charging points that are yet to be provided.

Ca. 140 fewer EV charging points

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Traffic counter & mobility micro census	Understand congestion level, routes taken by car & bicycle travel behaviours, trip purpose & mode on a five-year basis.	Highways and Traffic
B – Set up & run cycling network plan	Plan cycling routes based on Action A and local situation, ensuring save travel & crossing.	Highways and Traffic
C – Set up & run active travel schemes in schools and business	Introduce supported active travel, such as walking & 'Bicibus', introduce gaming & competition based on active travel mileage achieved as a team, such as 'Cycling for Trees'.	Highways and Traffic with support from Communications team
D – Tender bicycle sharing system	Introduce sharing bicycles in a station-based system to promote active travel.	Highways and Traffic
E – Run bicycle sharing system & increase number bicycles to share	Increase number of bicycles to rent.	Highways and Traffic with third party operator

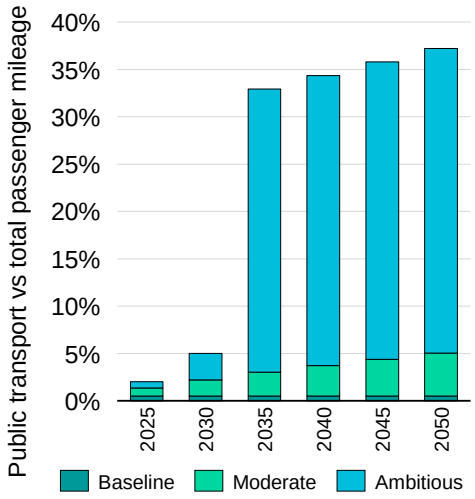
Alignment with UN's Sustainable Development Goals

Poverty (SDG 1), Good Health & Well-being (SDG 3), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15)

T2.2 Enhance the Public Transport Offering

Attractive Public Transport will be achieved by increased flexible time schedule and supported by demand transport with smaller vehicles and ride shares. The ticket price is already subsidized, however flexible rates depending on the congestion rates increase the shift from motorized individual transport to public transport. A free of charge public transport has the biggest influence on a modal shift.

Decarbonisation Pathways & Timeline



Baseline: Proceed with public transport service as usual. No additional measures are implemented.

Moderate: By 2035: subsidized flexible public transport ticket to reduce peak time in congestion addressing 20% of the peak times; by 2050: offering travel on demand service by about 100 vehicles.

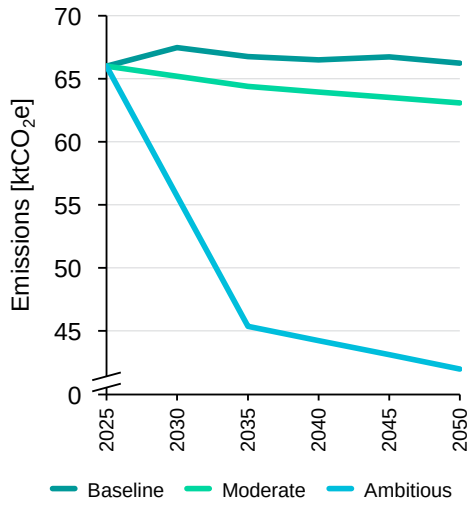
Ambitious: By 2035: free of charge flexible public transport without schedule and fixed bus stops; by 2050: offering travel on demand service by about 1000 vehicles.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**High**	**Medium**	**2.7 – 22** gCO_2e/km	**99 – 125** $£/kgCO_2e$	**1 – 13** £m/year

Considerations & Constraints

The implementation of free public transport requires a major investment in additional vehicles and fleet management. However, labour cost of drivers are the most significant expenditure (ca. £93k/year per timetabled bus) along with the acquisition of minibuses (ca. £67k per vehicle and 12 years lifetime) and cars for demand service (ca. £17k per vehicle and 10 years lifetime) as well as fuel costs (ca. £3k per vehicle and year) and traffic & fleet management (ca. £287k per year). Cost savings are on the individual level due to saved fuels. On average a resident would save up to £80 per year in the ambitious scenario.

Outcomes & Benefits



Shifting motorized individual transport to public transport reduces the direct emissions by 9.2 ktCO2e by 2050 to the increased efficiency per passenger mileage provided.

36% reduction in CO_2e

Although there are high costs associated with free public transport, the operating cost per resident are only 50% of cost savings of the residents due to saved fuels for private cars.

Reduced amount of travel spendings of residents

Reduced need for private cars would reduce the electricity demand of nearly 19,000 cars in Ambitious and with it the amount of EV charging points that are required.

Ca. 930 fewer EV charging points

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Set up Origin/Destination matrix	Understand travel behaviours, travel time, origin and destination, and plan public transport & on demand services accordingly.	Highways and Traffic
B – Set up public transport schedule	Plan demand & initial routes, ramp up of fleet stock continuously, adjust quarterly.	Highways and Traffic
C – Tender Travel App	Develop an app to provide real time information on bus schedule & routes, pick-up demands and capacity.	Highways and Traffic with support from Communications team
D – Tender vehicles	Increase number of vehicles in public transport.	Highways and Traffic
E – Test & launch App	Launch the app to connect demand and available capacity and allow the service to be rated.	Highways and Traffic with support from Communications team
F – Campaign & control on public transport	Inform residents & visitors; gain field data on transport pattern & capacity utilization.	Highways and Traffic with support from Communications team
G – Recruit drivers	Increase number of drivers in public transport, considering possible net migration and housing dependencies.	Highways and Traffic with third party operator
H – Install & operate public transport	Run public transport.	Highways and Traffic with third party operator

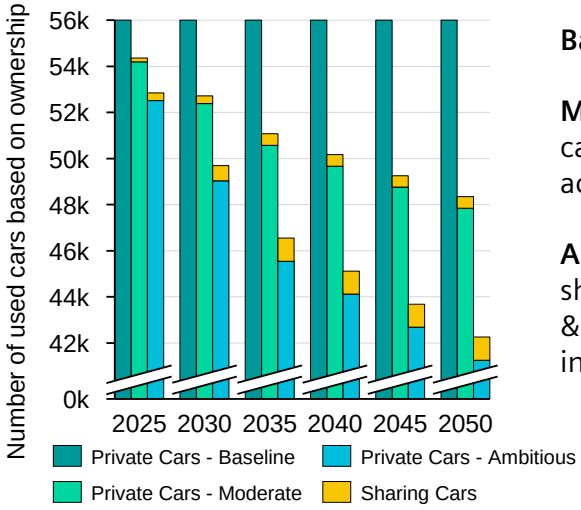
Alignment with UN's Sustainable Development Goals

Poverty (SDG 1), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13), Life on Land (SDG 15)

T2.3 Introduce Car and Ride Sharing Schemes

EV-car sharing schemes can replace the use of private cars sevenfold. With Guernsey having narrow roads, microcars would be ideal for residents and tourist to get around the Island in a fun way, whilst testing microcars in a non-committal setting. The fleet would be owned by SoG or an operator, and the operational costs will be covered by a sharing fee. Carpooling and ride sharing is further encouraged by parking and toll fees for single-occupied cars.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented.

Moderate: By 2035: 500 EV microcars are introduced as sharing cars; by 2050: carpooling is incentivized by free parking achieving nearly 10% increase in capacity utilization of cars

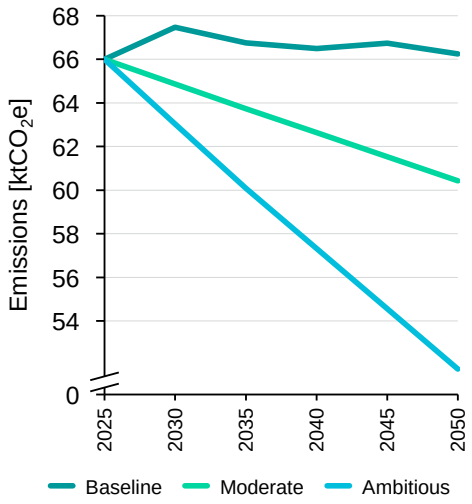
Ambitious: By 2035: 1000 EV microcars are introduced as sharing cars; by 2050: carpooling is incentivized by free parking & toll-fees for single-occupied cars achieving nearly 25% increase in capacity utilization

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**High**	**Medium**	**13 – 33** gCO_2e/km	**3.9 – 5.4** $£/kgCO_2e$	**2 – 4** £m/year

Considerations & Constraints

The implementation requires initial planning costs of ca. £500k, CapEx for microcars of £15k per vehicle with a lifetime of 8 years and setup costs for parking of £0.2k per parking spot for high occupancy cars. Introducing a parking fee of £2/hour for single-occupied cars could recover ca. 5% of the investment cost, assuming a 1hour parking time every ten days per car. Additionally, 25% can be financed by a toll fee of 7pence per km. The toll fee could be increased until private motorised transportation is reduced to the desired level. The toll system cost is the major part of the investment, accounting for £250k per year. Cost savings for the individual, due to saved fuels, are up to £157 per year per resident in the Ambitious scenario.

Outcomes & Benefits



Replacing single used cars with sharing cars and a ride sharing scheme reduces the direct emissions by up to 14.3 $ktCO_2e$ by 2050 due to better utilization and efficiency per passenger mileage.

Although there is high cost associated with the investment in the fleet, there are some new revenues from taxing single-occupied cars.

Reduced need for private cars of up to 7,000 EVs in the Ambitious pathway, and the associated EV charging points.

25% reduction in CO_2e

Innovative financing schemes

Ca. 350 fewer EV charging points

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Set up Origin/Destination matrix	Understand travel behaviours, travel time, origin and destination, and plan car sharing service accordingly.	Highways and Traffic
B – Set up sharing scheme, incl. parking space management & traffic toll	Plan car sharing system and incentivise car-pooling & ride sharing using parking space allocations and reduced traffic toll.	Highways and Traffic; Policy and Resources; Communications
C – Tender car sharing scheme, incl. vehicles	Provide reasonable number of vehicles to provide a flexible service and replace private cars.	Highways and Traffic
D – Tender App	Develop an app to provide real time information on ride sharing capability, parking spots and connect drivers and passengers for pick up, including rating schemes for passengers & drivers.	Highways and Traffic
E – Test & launch App	Launch the app to connect demand and available capacity, and rate service.	Highways and Traffic with support from Communications
F – Campaign & control sharing economy	Inform residents & visitors; gain field data on transport pattern & capacity utilization.	Highways and Traffic with support from Communications
G – Install & operate car sharing system & sharing APP	Increase number of sharing cars and rides shared.	Highways and Traffic with support from Communications; Third party operator

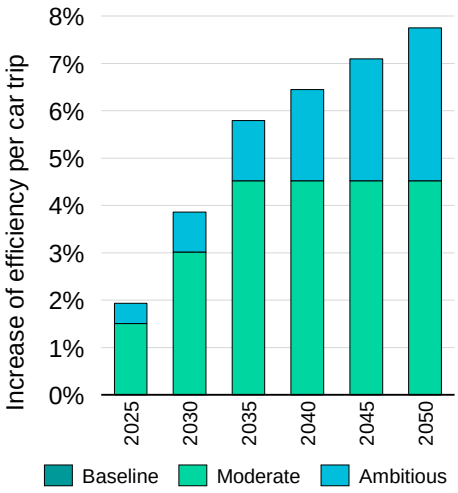
Alignment with UN's Sustainable Development Goals

Good Health & Well-being (SDG 3), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15)

T2.4 Introduce Dynamic Tolling and Parking Fees for Motorised Vehicles

Fuel efficiency of vehicles is influenced by considerate driving behaviours and a constant traffic flow. Both can be achieved by eco-efficient driving training for permit holders and introducing dynamic tolling, particularly during peak times, and effective parking management, which directs drivers to available parking spaces.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented.

Moderate: By 2035; 25% of the drivers are trained; 20% of the parking spaces are managed; 20% of the road network is managed by dynamic tolling

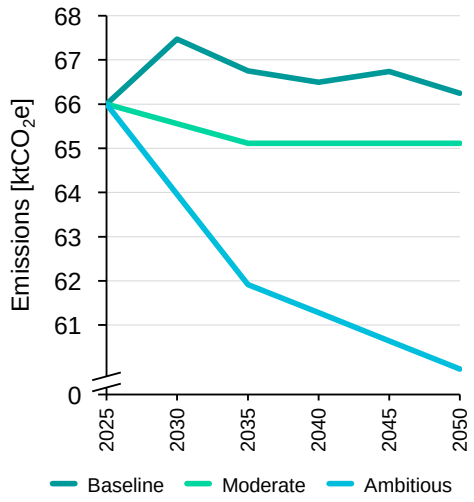
Ambitious: By 2050: 50% of the drivers are trained; 100% of the parking spaces are managed; 100% of the road network is managed by dynamic tolling

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**High**	**Medium**	**7 – 14** gCO_2e/km	**1.25 – 2** $£/kgCO_2e$	**0 – 2** £m/year

Considerations & Constraints

Expenditure includes initial planning cost of £500k and setup cost for parking management (ca. £0.2k per parking spot). Introducing a parking fee of £2/hour for all cars could recover ca. 40% of the investment cost, assuming a 1hour parking time every ten days per car. Additionally, 30% can be financed by a toll fee of 7pence per km during peak times, which are assumed to be 4h per day. The toll system cost is the major part of the investment, accounting for £250k per year. Cost savings for the individual, due to saved fuels, are up to £66 per year per resident in the Ambitious scenario, assuming a fuel price of £1.55 - 1.62 per litre.

Outcomes & Benefits



Improving driving efficiency of individual motorised vehicles reduces the direct emissions of fuel combustion by up to 6 $ktCO_2e$ by 2050.

Cost associated with the investment in the toll & parking management system can be partly recovered by new revenues from these systems.

Dynamic tolling based on congestion levels can shift between 5% and 20% of demand to other modes of transport.

12% reduction in CO_2e

Innovative financing schemes

Reduction of congestion rate

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Set up & conduct driver training	Encourage environmental conscious driving behaviours with incentive scheme.	Highways and Traffic with third party operator
B – Set up parking space management & traffic toll	introduce parking space management and dynamic traffic toll scheme.	Highways and Traffic ; Policy and Resources; Communications
C – Tender parking & toll system	Provide infrastructure for parking management and dynamic toll.	Highways and Traffic
D – Tender App	Develop an app to allow navigation to free parking spots & financial management of toll.	Highways and Traffic
E – Test & launch App	Integrate the app's payment functions with the State's taxation systems.	Highways and Traffic; IT Department
F – Install & operate parking & toll system & App	Reduce congestion level and car traffic.	Highways and Traffic; Communications; Third party operator

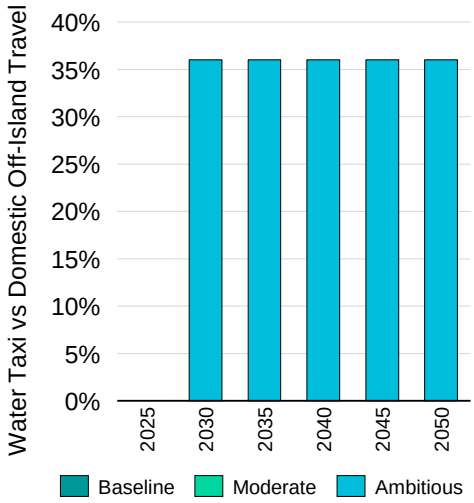
Alignment with UN's Sustainable Development Goals

Good Health & Well-being (SDG 3), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11)

T2.5 Introduce a High-speed Electric Water-Taxi Service

Introduce a high-speed water taxi service between Guernsey and all Channel Islands and remove a need for flights between Guernsey and Alderney and Jersey. New models of hydro foiling vessels have recently entered the market, which can reach speeds of up to 35 knots, and a return trip between Guernsey and Jersey can be achieved on a single charge.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented.

Moderate: No additional measures are implemented.

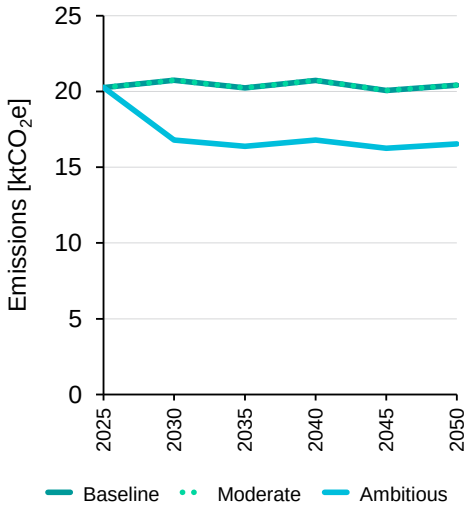
Ambitious: In 2030, all flights to Jersey and other Islands in the Bailiwick of Guernsey switch to electrified water taxis.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Low	**Medium**	**Medium**	**~164** kgCO_2e/trip	**3.4 – 4.2** £/kgCO_2e	**~3** £m/year

Considerations & Constraints

To maximise the GHG reduction benefits of this intervention, it is essential that the water taxis are powered by zero-carbon fuels, such as electricity. Equally, there will need to be a financial incentive and/or regulation in place to ensure that journeys are switched from air travel to water taxis. If air travel is not banned, travel by water taxis will need to offer other advantages, such as being cheaper, faster, or more frequent. Charging infrastructure at all destination ports need to be considered, too, to ensure that the water taxis can be recharged as necessary.

Outcomes & Benefits



A coordinated introduction of short-haul, high-speed, electric water taxis between the Channel Islands could save up to 4 ktCO_2e of emissions.

Operating the water taxi service offers the potential to create additional jobs, and possibly reduce on-Island transport by establishing a north-south or around-the-Island route.

Hydro foil vessels are less impacted by tidal constraints and offer a more convenient and reliable service.

19% reduction in CO_2e

Employment opportunities

Improves productivity

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Identify the routes that could be replaced	Identify routes that could be switched from flying to water taxis.	Highways and Traffic; Guernsey Ports; Collaboration with States of Jersey
B – Consult with stakeholders	Ascertain the level of support and demand from citizens and businesses in the Bailiwick of Guernsey and Jersey. Ascertain interest from service providers to run a water taxi service. Carry out an impact assessment on infrastructure needed at the seaport(s) to accommodate a service and vessels, together with need to address tidal constraints. Carry out an impact assessment on the implementation of electricity supply infrastructure. Carry out an impact assessment on airport and airline if such a transition were implemented.	States of Guernsey and Jersey with support from applicable department; Guernsey & Jersey Ports; Guernsey Electricity; Support from specialist domain experts e.g., civils, infrastructure etc.
C – Develop proposition	Define the high-level service offering, together with development of the business case and supporting feasibility studies.	Guernsey's & Jersey's Transport Departments
D – Tender for water taxis	Review suitability of vessels and service providers and procure products and services from relevant third parties to implement enabling works and infrastructure and introduce the electric water taxis vessels and service offering.	States of Guernsey with support from departments and third-party providers
E – Transition away and cease unnecessary flights	Plan and implement a phased transition from short-haul flights to electric water taxis and cease (or reduce) competing flights.	States of Guernsey with support from States of Jersey

Alignment with UN's Sustainable Development Goals

Industry, Innovation & Infrastructure (SDG 9), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13), Life on Land (SDG 15), Partnerships for the Goals (SDG 17)

5.3 Theme 3: Electrify and use renewable fuels

This theme includes several interventions with a focus on switching to using electric vehicles, vessels and heating, and existing heating systems, vehicles and vessels switching to using only renewable fuels.

T3.1: Use electricity and low-carbon fuels to heat residential buildings

T3.2: Use low carbon energy for commercial and industrial buildings and processes

T3.3: Align with the UK's Jet Zero strategy

T3.4: Use alternate fuels in marine vessels

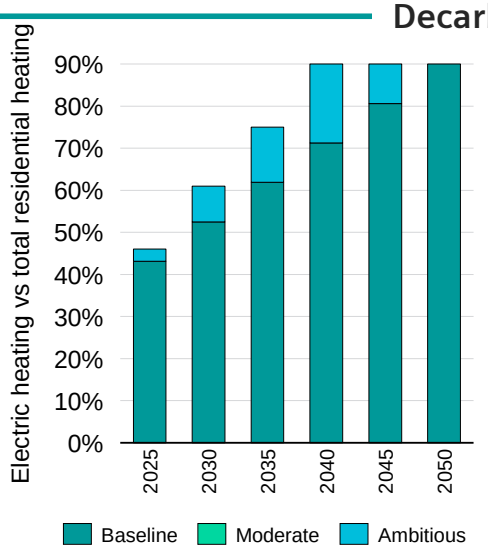
T3.5: Encourage electric vehicle adoption and ban ICE vehicle imports

T3.6: Switch existing road vehicles to using renewable fuels

T3.1 Use Electricity and Low-Carbon Fuels to Heat Residential Buildings

The main contributor to GHG emissions from residential buildings are their heating systems. Currently, around 65% of houses use fossil fuel combustion heating, powered with gas oil, kerosene or LPG. By replacing these heating systems with electric ones, such as electric boilers or heat pumps, a significant emission reduction could be achieved. However, acknowledging the complexity in this process, some heating systems could be switched to biofuels instead.

Decarbonisation Pathways & Timeline



Baseline: By 2050, 90% of heating systems are electric.

Moderate: By 2050, 90% of heating systems are electric with the remaining 10% being powered by renewable fuels. The introduction of renewable fuels starts in 2035 with some fuels being generated by an AD plant on-Island.

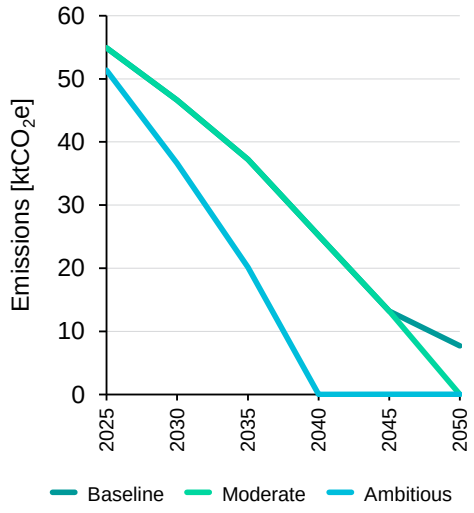
Ambitious: By 2040, 90% of heating systems are electric with the remaining 10% being powered by renewable fuels. From 2035, the majority of renewable fuels are supplied by the AD and gasification plants, and electricity's carbon factor is 0 g/kWh.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**Medium**	**0.2 – 0.3** kgCO₂e/kWh	**3.3 – 3.8** £/kgCO₂e	**39 – 47** £m/year

Considerations & Constraints

The scale of the electrification requires careful consideration with regards to the impact on the electricity grid. Therefore, the co-deployment of local generation assets should be encouraged. At larger development sites, the installation of heat networks should also be considered, particularly with nearby heat sources. Technical challenges to electrifying certain buildings still exist, particularly listed ones. Hence, this intervention should be considered in conjunction with energy efficiency improvements. It is worth noting that electrification has a sustained benefit from an emission's perspective over using low-carbon fuels.

Outcomes & Benefits



Transitioning from fossil fuels to electrically powered low-carbon heating system reduces emissions by up to 59 ktCO₂e.

Households can benefit from lower energy bills and an increase in property value.

Using electric heating over combustion alternatives reduces localised air pollution.

Up to **99%** reduction in CO_2e

Predictable and lower bills

Reduced Air Pollution

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Building Heating Audit	Conduct a thorough review of the existing heating mechanisms, including various stakeholders, such as suppliers, distributors and end-users	States of Guernsey
B – Low Carbon Heating Strategy	Identify clusters and develop heating strategy for new and existing buildings, setting targets on the percentage of electric and non-electric heating systems and identifying co-location benefits, e.g. combining the AD plant with a heat network	States of Guernsey
C – Options for Listed Buildings	Outline measures and support for building owners, particularly those that may have additional challenges, such as being in conservation areas.	States of Guernsey with support from Planning
D – Ban fossil fuel heating systems	Legislate to ensure all fossil fuel powered heating systems are converted to electric or low-carbon fuel alternatives.	States of Guernsey

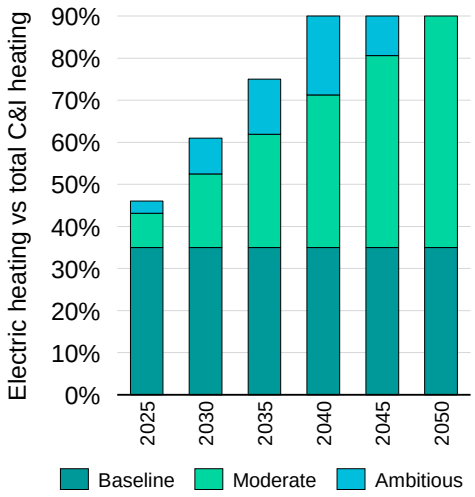
Alignment with UN's Sustainable Development Goals

Poverty (SDG 1), Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13), Life on Land (SDG 15)

T3.2 Use Low Carbon Energy for Commercial & Industrial Buildings and Processes

Businesses use gas oil and kerosene primarily for space heating and, in some cases, use conventional fuels in plant and equipment to carry out industrial processes. This intervention reduces GHG emissions in buildings by replacing existing fossil fuel heating systems with electric heating systems and introducing electrified machinery for industrial processes, and using biofuels instead to achieve a significant emission reduction.

Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented.

Moderate: By 2050, 90% of commercial and industrial heating systems and processes are electrically powered and all remaining heating and process fuels are replaced by renewable fuels from 2050 onwards.

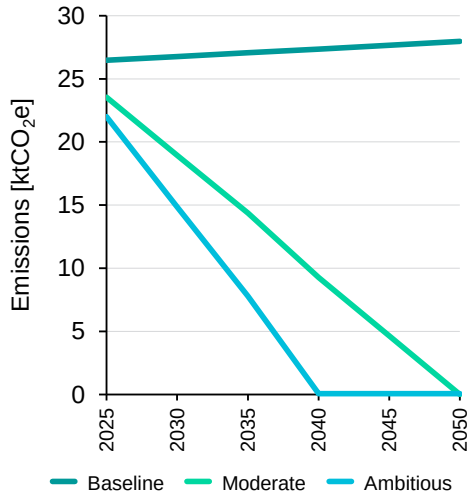
Ambitious: By 2040, 90% of commercial and industrial heating systems and processes are electrically powered and all remaining heating and process fuels are replaced by renewable fuels. From 2035, the majority of renewable fuels are supplied by the AD and gasification plants, and electricity's carbon factor is 0 g/kWh.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Medium**	**Medium**	**0.2 – 0.3** kgCO₂e/kWh	**6.7 – 8.5** £/kgCO₂e	**39 – 47** £m/year

Considerations & Constraints

Switching to electrified equipment for industrial processes may incur a higher differential cost, and skill-related impacts may need to be considered. Adoption levels will depend on cooperation from businesses, which might necessitate incentives to help small businesses. States of Guernsey could introduce measures in public buildings as case studies. Capacity of electricity supply will need to increase to meet future demand, together with necessary distribution network reinforcements.

Outcomes & Benefits



Transitioning from using fossil fuels to electrically powered heating systems reduces sector emissions by up to 26 ktCO₂e.

Up to **99%** reduction in CO₂e

Businesses procure electricity and renewable fuels at predictable price levels, achieved by a high proportion of locally generated renewable electricity and locally produced BioLPG and Biomethane.

Predictable energy costs

Procuring locally produced biofuels to meet non-electrified business needs from 2030 onwards contributes to a circular economy.

Fosters a circular economy

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Baseline commercial and industrial energy uses and engage with organisations	Engage with businesses, investors and other partners. Map data over existing heating status (validity of installations, possibility of technical modification, kW rating). Prepare energy estimations based on standards (ASHRAE e.g.). Develop action plan, involving businesses, investors and partners.	States of Guernsey
B – Lead with pilot projects and showcase viability	Implement electrification in States of Guernsey buildings, and use of indoor and outdoor plant and equipment. Establish agreements with businesses to pilot and define preferable energy measures to assess benefits. Secure potential investment schemes and consider subsidies needed and capacity to perform end-of-life for replaced units. Evaluate pilot projects towards achieving decarbonization strategy compliance and delivering on expected benefits.	States of Guernsey with participation from local businesses
C – Scale and monitor electrification, and switching to bio-fuels	Begin replacement of fossil fuel dependent heating systems with electric/biofuel driven ones e.g., heat pumps for industrial and related processes and electric boilers for commercial sector. Monitor the speed of implementation in relation to targets of achieving 90% electrification of heating systems by 2050 (Moderate pathway) and 2040 (Ambitious pathway). Adjust incentives and disincentives as may be necessary.	Local businesses with monitoring by States of Guernsey

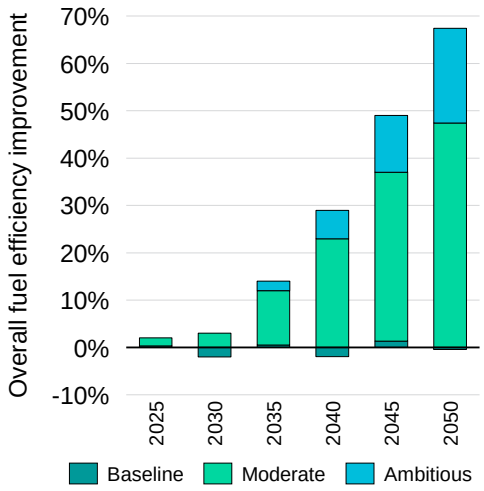
Alignment with UN's Sustainable Development Goals

Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13), Life on Land (SDG 15)

T3.3 Align with the UK's Jet Zero Strategy

Aviation is an important mode of travel for passengers, with direct routes between Guernsey and Alderney, Jersey and the UK, and an increasing choice of direct routes to other European destinations. This intervention aims to reduce the carbon intensity of future flights through fuel efficiency improvements, replacing conventional fuels with sustainable aviation fuel (SAF), and increasing the use of zero emission aircraft that are domiciled in Guernsey.

Decarbonisation Pathways & Timeline



Baseline: Alignment with Scenario 1 of the UK's Jet Zero strategy, which assumes 1.5% annual fuel efficiency improvements, 10% use of SAF (unable to remove) and no zero-emission aircraft movements by 2050.

Moderate: Alignment with Scenario 2 of the UK's Jet Zero Strategy, which assumes a 2% annual fuel efficiency improvements, 50% use of SAF and 27% zero-emission aircraft movements by 2050.

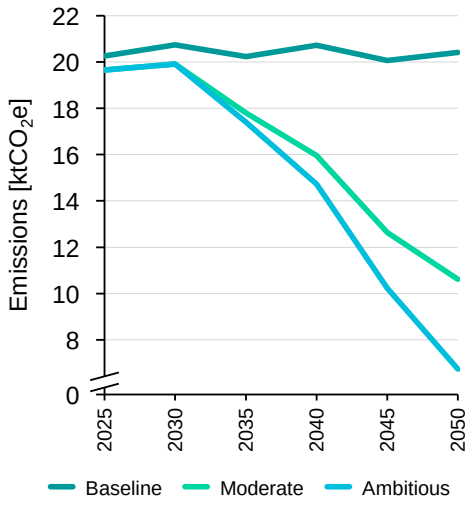
Ambitious: Alignment with Scenario 3 of the UK's Jet Zero Strategy, which assumes the same as the Moderate pathway but with 100% use of SAF by 2050.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Low	**High**	**Medium**	**10 – 14**	**N/A**	**N/A**
			$ktCO_2e$/year	£/$kgCO_2e$	£m/year

Considerations & Constraints

Adequate quantities of SAF to be procured at reasonable cost, requiring financial support either to subsidise differential costs or to support suppliers in increasing volumes to meet demand. Investment required to modify existing storage infrastructure or introduce additional storage alongside that used for conventional fuels. Additional tanker journeys will be required to/from the airport to deliver both fuel types during a transition period. Achieving Jet Zero depends on international cooperation between governments and regulatory bodies, and also depends on technology development.

Outcomes & Benefits



Using SAF in all domiciled aircraft reduces aviation emissions by up to 14 $ktCO_2e$.

By adopting efficient aircraft, airlines can lower operating costs, making air travel more affordable for passengers.

Reducing emissions improves air quality around airports and flight paths, benefiting local communities.

Sustainable aviation will future-proof Guernsey's aviation sector and create green jobs.

67% reduction in CO_2e

Improved fuel efficiency

Improved air quality

Sustainable aviation jobs

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Monitor the UK's Jet Zero progress	Engage with UK government and monitor implementation of the strategy.	States of Guernsey
B – Develop a timetable for using SAF	Collaborate with airport, airline and fuel suppliers to consider commercial and operational practicalities of using SAF, together with infrastructure dependencies. Develop an accelerated timetable for using SAF in commercial and private aircraft at different levels e.g., 25%, 50%, 100%. Consider need for subsidies to reduce the impact of differential costs compared to conventional fuels and opportunities to incentivise production.	States of Guernsey with Guernsey Airport, Aurigny and Fuel Distributors
C - Develop a timetable for electric private aircraft	Explore opportunities to encourage private aircraft owners to switch to using electric-powered alternatives, and plan for the implementation of adequate charging infrastructure.	Guernsey Airport with support from Guernsey Electricity
D – Promote Guernsey as a Jet Zero lab	Collaborate with industry and research institutions to explore opportunities to position Guernsey airport as living lab to proving Jet Zero, which might include introducing electric aircraft and rapid switching to using SAF in existing aircraft.	States of Guernsey

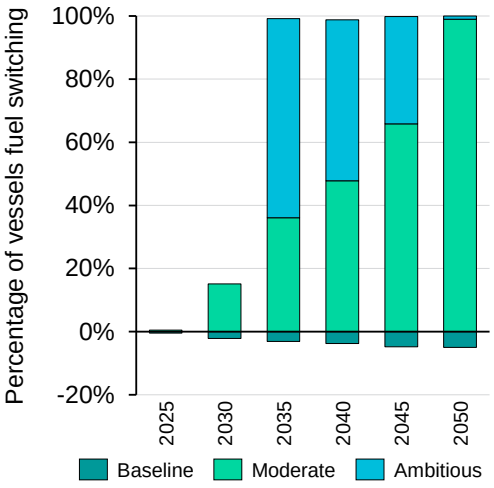
Alignment with UN's Sustainable Development Goals

Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15), Partnerships for the Goals (SDG 17)

T3.4 Use Alternate Fuels in Marine Vessels

Maritime activity in Guernsey's waters includes passenger and cargo ships, fishing and recreational vessels and visiting cruise ships. This intervention considers electric, biofuel or ammonia as alternate fuels. The lack of disaggregation by vessel type in the GHG inventory means that this intervention doesn't distinguish between vessel types. However, electrification of recreational and fishing vessels, and ships used for short trips should be encouraged.

Decarbonisation Pathways & Timeline



Baseline: No change in fishing vessel activity, and fuel and gas oil use in other vessels increases in line with population.

Moderate: From 2030, ammonia will be part of the fuel mix, as stated by CCC's Balanced Net Zero pathway. By 2035, a third of vessel will have switched, with no conventional fuels used by 2050.

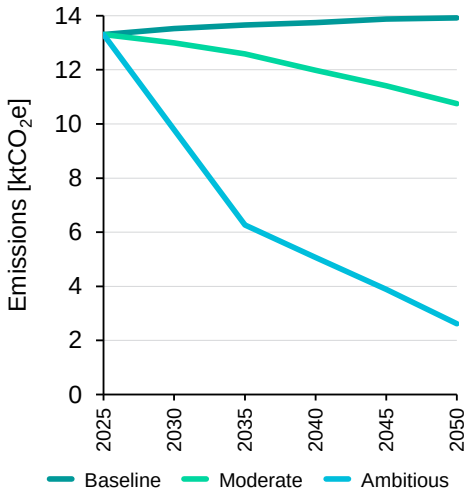
Ambitious: From 2030, ammonia will be part of the fuel mix, as stated by CCC's Balanced Net Zero pathway. By 2035, all vessels will have switched, with no more conventional fuels used.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Low	High	Low	12 – 15 ktCO₂e/year	2.7 – 3.4 £/kgCO₂e	9 – 10 £m/year

Considerations & Constraints

Adoption barriers include significant costs of technology change, alternative fuels, and infrastructure modifications like portside rapid charging and fuel storage facilities. Incentives or regulations are crucial. Vessel owners need realistic, economical mandates to prevent non-participation or jurisdiction shifts. A phased approach, targeting recreational boats before commercial vessels, could be effective. Training on new vessel technologies and alternate fuels is essential for workers. Increasing vessel owners' awareness of new technology benefits and ensuring support and maintenance structures are vital.

Outcomes & Benefits



Electrification and use of alternate fuels could reduce emissions by up to 14 ktCO₂e by 2050, whilst eliminating air and marine pollutants.

Biofuels offer a drop-in fuel that means action can be taken immediately at relatively low cost.

Green marinas, which might prioritise sailed vessels, could attract green tourism.

Up to 88% reduction in CO_2e

Potential tourism benefits

Reduce pollution

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Monitor technology trends and markets	Any regulatory or fiscal measures to restrict fossil fuel vessels and encourage alternatives fuels will need to be in line with market trends.	Port Authority
B – Engagement with vessel owners	Consult with vessel owners on perception and willingness to transition fuel use, whilst auditing stock composition.	Port Authority
C – Regulatory and/or fiscal measures to encourage move to alternative fuels	Identify the most appropriate measure or combination of measures for incentivising the move to alternative fuels.	States of Guernsey
D – Training of people to work in this area	Support the training of workers to install and maintain technology associated with alternative fuel vessels. Also consider bringing this expertise in from elsewhere to supplement on-Island training.	Port Authority & States of Guernsey

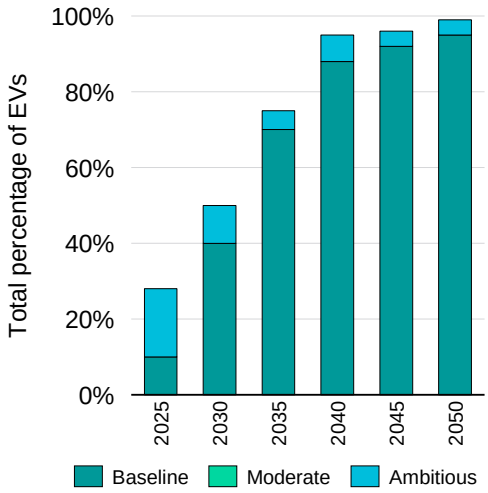
Alignment with UN's Sustainable Development Goals

Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life Below Water (SDG 14), Life on Land (SDG 15)

T3.5 Encourage Electric Vehicle Adoption and Ban ICE Vehicle Imports

Shifting ICE vehicles to EVs reduces the emission factor per MJ provided by 98% and increases the efficiency of vehicles by a factor of three (3). The Electricity Strategy for Guernsey has considered generating the required electricity locally using renewable sources. Currently, the ban on buying new ICE vehicles in Guernsey is tied to UK legislation, which had its target start year recently delayed from 2030 to 2035.

Decarbonisation Pathways & Timeline



Baseline: By 2035: new ICE vehicle ban, resulting in 95% EV adoption in 2050. Buses are replaced after a service time of 12 years as diesel buses before 2035 and as electrical buses after 2035.

Moderate: No additional measures to be implemented.

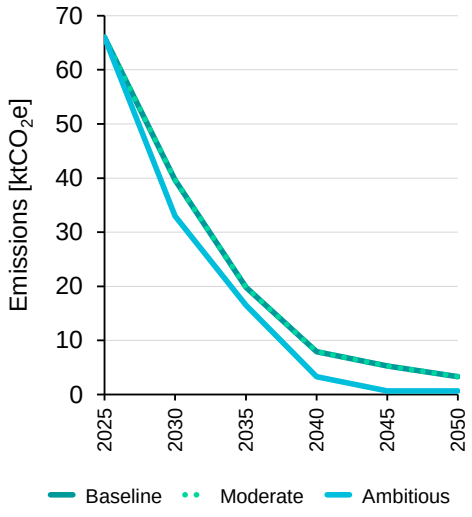
Ambitious: By 2030: new ICE ban and phase out existing ICE vehicles by 2040; resulting in 99% EV adoption in 2050. Buses are replaced by electrical buses after a service time of 12 years.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**Medium**	**~148** gCO₂e/km	**1.1 – 1.2** £/kgCO₂e	**3 – 4** £m/year

Considerations & Constraints

Expenditure includes initial planning cost of £500k, setup costs for EV charging points of £2.5k each considering a 10-year lifetime, and annual operating costs of £0.8k per charging point per year. It is assumed that 20 vehicles are served by one charging point. Cost savings for individual drivers, due to saved fuels, are up to £896 per year in the Ambitious scenario, assuming a fuel price of £1.55 - 1.62 per litre. However, enforcing purchases of EVs might be unpopular with certain user groups, and the general behaviour change in operating EVs will also need to be considered, e.g., charging over night.

Outcomes & Benefits



Shifting from combusting fossil fuels to powering vehicles with electricity reduces the direct emissions by 63 ktCO2e by 2050, particularly as electricity has a better emission factor per MJ.

EVs have a better efficiency per passenger mileage provided and can therefore provide additional cost savings compared to conventional fuel.

For remaining ICE vehicles, the only fuel option will be renewable fuels from 2035 (Ambitious pathway) or 2050 (Moderate pathway).

97% reduction in CO_2e

Lower operating cost for drivers

Ban on conventional fuels beyond 2035

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Set up EV charging strategy	Plan charging points, public, semi-public and private	Highways and Traffic with support from Guernsey Electricity
B – Set up incentive scheme for infrastructure provider	Reduce number of charging stations to be built on public spaces and ensure well distributed charging points across the island	Highways and Traffic with support from Guernsey Electricity and other third-parties
C – Tender EV charging infrastructure	Provide infrastructure for EV charging in shared public settings	Highways and Traffic with support from Guernsey Electricity and other third-parties
D – Install & operate EV charging infrastructure	Achieve reliable & easy to access EV charging points	Third-party operators
C – Set up incentive scheme for EV owners	Provide financial incentives, such as grants and tax-rebate to support individuals and business with the upfront expenditure	States of Guernsey (Policy & Resources)

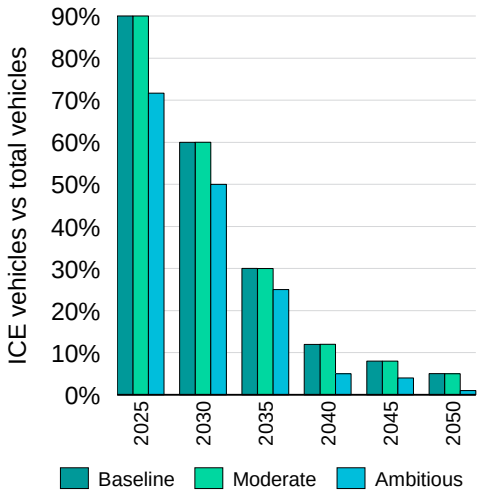
Alignment with UN's Sustainable Development Goals

Good Health & Well-being (SDG 3), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15)

T3.6 Switch Existing Road Vehicles to using Renewable Fuels

This intervention is linked to the increase in EV adoption levels on Guernsey, as well as the other road transport interventions, which will lead the shift away from ICE vehicles. By replacing all consumer facing conventional fuels with renewable fuels, the overall emissions from the residual ICE stock can be reduced further due to the ~99% lower emission factor of renewable fuel, e.g. biodiesel compared to conventional diesel.

Decarbonisation Pathways & Timeline



Baseline: No additional measures to be implemented.

Moderate: In 2050, all supply of conventional fuels to private consumers cease, and only renewable fuels are made available

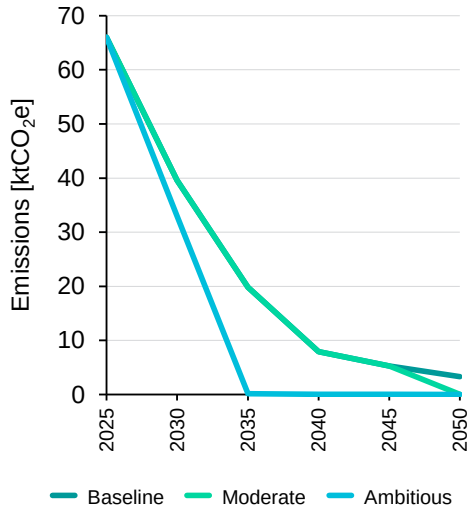
Ambitious: In 2035, all fuel supplies will be renewable, either locally produced or imported

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Medium**	**Medium**	**~147** gCO$_2$e/km	**1.3 – 1.4** £/kgCO$_2$e	**N/A** £m/year

Considerations & Constraints

Switching Guernsey's fuel distribution network, including forecourts, to renewable fuels will require considerable coordination and planning. Guernsey is in the fortunate position that it has already renewable fuel supply in circulation. However, without a legislated switch-over date from Government, distributors will not be able to transition demand themselves. It is worth noting that no cost savings for individual drivers are anticipated, as biofuels command a higher price than conventional fuels, particularly as many supply chains worldwide rely on them to decarbonise.

Outcomes & Benefits



Shifting fossil fuel consumption to renewable fuel reduces the direct emissions of fuel combustion by up to 17 ktCO$_2$e in 2035.

Faster reduction due to early switching to renewable fuels, with an emission factor close to zero in combination with the ban of new ICE vehicles.

Achieve sector decarbonization up to 15 years earlier with the complete phase out of fossil fuels.

25% reduction in CO$_2$e in 2035

Creates a demand for locally produced biofuels

Reduce cumulative emissions

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Develop a renewable fuel strategy	Plan import and on-Island production and storage requirements to meet predicted demand.	States of Guernsey (Environment & Infrastructure)
B – Consult stakeholders	Engage with local fuel importers and distributors, and potential producers, to align on a common carbon neutral vision.	States of Guernsey (Environment & Infrastructure) with input from local fuel distributors
	Engage with citizens and businesses to provide reasonable notice on the possible change, and what actions will be required.	Communications
C – Legislate the transition timeframe	Provide clear guidance on the transition period to enable forward looking decision makers from suppliers and consumers alike.	States of Guernsey
D – Provide financial support	Support consumers to overcome technical issues during transition period	States of Guernsey (Environment & Infrastructure)
E – Communicate with international community	Monetise the acquired knowledge and share the know-how of decarbonising the road transport sector	States of Guernsey (Environment & Infrastructure)

Alignment with UN's Sustainable Development Goals

Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13)

5.4 Theme 4: Produce renewable electricity and fuels

This theme includes several interventions with a focus on implementing the electricity strategy to enable electrification, and utilising local waste and wastewater to locally produce sustainable fuels for heating and transport.

T4.1: Implement the electricity strategy and increase offshore wind

T4.2: Produce biofuels from food and agriculture waste

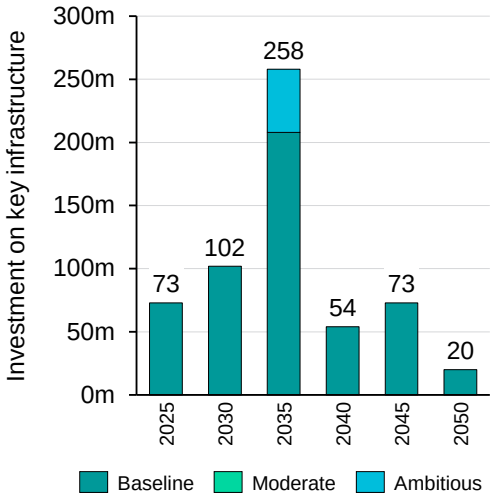
T4.3: Introduce a wastewater treatment plant with anaerobic digestion

T4.4: Produce BioLPG from refuse and biomass in a gasification plant

T4.1 Implement the Electricity Strategy and Increase Offshore Wind

The adopted Electricity Strategy outlines a supply pathway for the Island that optimally meets the existing energy and climate change policies. The associated delivery programme is not underway yet, and capacity sizes, e.g., of the interconnector or offshore windfarm, can still be adjusted. Hence, the renewable electricity generation assets could be increased to reduce the carbon content further.

Decarbonisation Pathways & Timeline



Baseline: From 2030, a new interconnector to France with a 100 MW capacity is introduced; from 2035, an offshore windfarm with a 65 MW capacity becomes operational and from 2040, any remaining on-Island thermal generation is powered by hydrogen.

Moderate: No additional measures to be implemented.

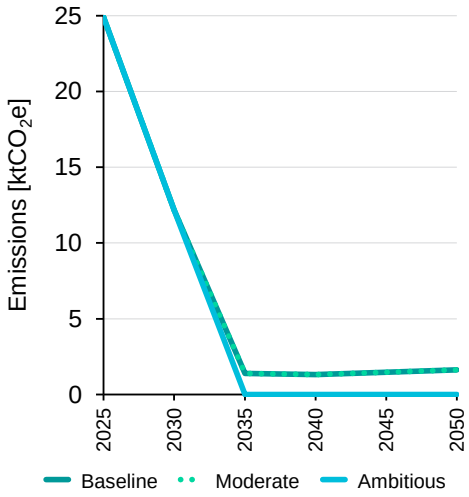
Ambitious: From 2035, the capacity of the installed offshore windfarm is 80 MW, and any electricity imported from France has a carbon intensity of 0 gCO_2e/kWh.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**High**	**High**	**58 – 80**	**22 – 24**	**47 – 51**
			$kgCO_2e/kW$	$£/kgCO_2e$	£m/year

Considerations & Constraints

Other interventions may impact the sizing of the technologies recommended in the Electricity Strategy, which will therefore need to be reviewed. Also, the commercial interests of delivering partners, particularly of the interconnector and offshore windfarm, will define the scale and timing of implementation, particularly as they coincide with other jurisdictions' efforts to decarbonise. De-risking these activities by establishing relations with UK Crown Estates and France is therefore advisable. The opportunity to produce hydrogen from renewable electricity, e.g., by increasing the windfarm, could also be considered.

Outcomes & Benefits



Investing in an offshore windfarm and a new interconnector to France reduces emissions by up to 25 $ktCO_2e$.

Surplus electricity can be sold back or used as a flexible demand incentive.

Enhances energy security by increasing the level of electricity that is self-generated and reducing the risk of single-point failures.

Up to **99%** reduction in CO_2e

Surplus generation for export

Improves energy security

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Agreement in principle with France and Jersey	Agree terms for higher levels of export to France.	States of Guernsey with support from Guernsey Electricity
B – Revise Import/export model and terms	Develop (or amend) as necessary the commercial and technical agreements for importing and exporting electricity via one of the interconnectors.	Guernsey Electricity
C – Consenting of seabed and leasing terms	Allocate the additional area required to accommodate the additional offshore wind turbines and reduce commercial risk for developers.	States of Guernsey (Policy and Resources)
D – Identify need for additional network reinforcements	Ensure that the existing electricity network will support the increased level of offshore wind generation, which should be assessed through detailed technical analysis that considers power flows at all voltage levels.	Guernsey Electricity

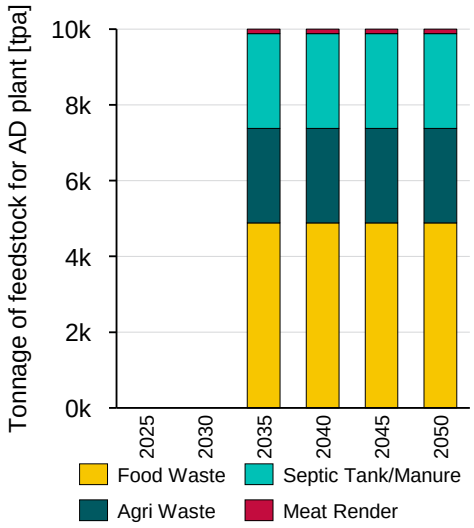
Alignment with UN's Sustainable Development Goals

Poverty (SDG 1), Good Health & Well-being (SDG 3), Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life on Land (SDG 15), Partnerships for the Goals (SDG 17)

T4.2 Produce Biofuels from Food and Agriculture Waste

Introduce an Anaerobic Digestion (AD) plant in Guernsey that collects biogas from food and agriculture waste, and wastewater collected from septic tanks. By processing the biogas further, 2.5 million litres of a liquid biomethane fuel could be produced each year for use in road vehicles and marine vessels, and for space heating.

Decarbonisation Pathways & Timeline



Baseline: No measure is implemented. Food waste is exported to a Biogen UK AD plant in Basingstoke.

Moderate: From 2035, ~£10m investment in an AD plant in Guernsey could produce 2.5M litres of Biomethane from 10,000tpa of feedstock. The produced biofuel is locally consumed in road vehicles, marine vessels, and buildings.

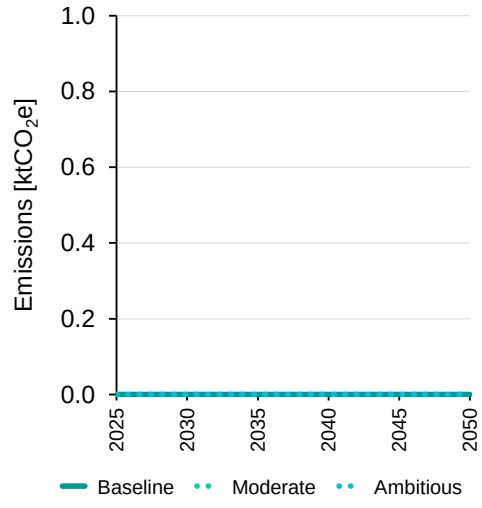
Ambitious: No additional measures are implemented compared to the Moderate pathway.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**Medium**	**0.6 – 0.8** tCO_2e/t_{waste}	**1.3 – 1.6** $£/kgCO_2e$	**~2** £m/year

Considerations & Constraints

An AD plant using food and agriculture waste will require a footprint of approximately 1-1.2ha and could be sited adjacent to the existing WTS facility at Longue Hogue. The AD plant would operate 24/7/365 due to the nature of a continuous Anaerobic Digestion process. An impact assessment on transport and traffic would be needed. The resulting sanitized anaerobic digestate may be discharged into the sea. The States of Guernsey would need to introduce a policy that changes the present policy of exporting food waste and decide on the level of public and/or private participation in the ownership and operation of the AD plant.

Outcomes & Benefits



Using biomethane can reduce emissions by up to 90% compared to using conventional fuels, however, these benefits are attributed at the point of consumption.

90% reduction in CO_2e

Locally managing waste eliminates 67 tCO_2e of export related road transport emissions each year, and contributes positively to energy security and self-sufficiency.

Jobs and economic growth

Managing this waste locally, using an AD plant, creates employment and economic growth in the energy sector.

Improves Energy security

Associated Actions & Responsibilities

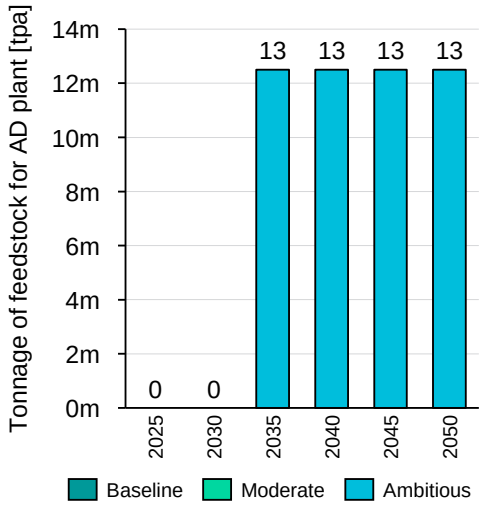
Action	Objectives	Responsibility
A – Develop policy and strategy	Define and approve a policy of retaining wastes as a feedstock and locally producing Biomethane fuels for use in transport, residential and business sectors. Identify possible sites and consult with interested participants and community on the principles of local fuel production, using food and agriculture waste as feedstocks and utilizing or discharging the sanitized digestate.	States of Guernsey
B – Pre-feasibility assessment	Undertake pre-feasibility scoping studies, including an assessment of appropriate co-digestion AD technology to handle food, agriculture (crop/manure), meat rendering and wastewater (septic tank) feedstocks.	Guernsey Waste
C – Detailed feasibility study	Carry out full feasibility study, which should include site assessment, transport and traffic impact assessment associated with collecting feedstocks and transporting fuels, options for ownership and operating models, product offerings and go-to-market options, and identification of capital and operating expenditures.	Guernsey Waste with States of Guernsey approvals
D – Investment case and target operating model	Create the investment case and explore uses of equity and debt, together with the role of public and/or private partnerships.	States of Guernsey
E – Tendering specifications and Procurement	Prepare tender specifications, assess and appoint parties in connection with the construction, commissioning and operating phases.	Guernsey Waste
F – Product offerings and go-to-market launch	Establish supply chains for procuring and transporting incoming feedstocks and supply of fuels for target use cases e.g., uses in road vehicles, marine vessels, and for space heating.	Guernsey Waste with private sector participation from Energy Partnership and/or new partners outside of Guernsey's jurisdiction
G – Commission, operate and scale AD production	Commence operations from 2030 and scale the availability of Biofuels within the first six months from date of commissioning.	AD Plant Operator (may be a private and/or public entity) with appointed Fuel Distributors

Alignment with UN's Sustainable Development Goals

Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12)

T4.3 Introduce a Wastewater Treatment Plant with Anaerobic Digestion

Introduce a water treatment facility coupled with an Anaerobic Digestion (AD) plant in Guernsey that collects biogas from an average of 12.5 million litres of mains wastewater that is processed each day. By using CCS technology, the biogas can be converted into 11 million litres of liquid biomethane fuel each year for use in road vehicles and marine vessels, and for space heating.



Decarbonisation Pathways & Timeline

Baseline: No measure is implemented. Wastewater is passed through screens and discharged via the Belle Greve Wastewater Centre into the sea via an outfall pipe.

Moderate: Same as Baseline pathway.

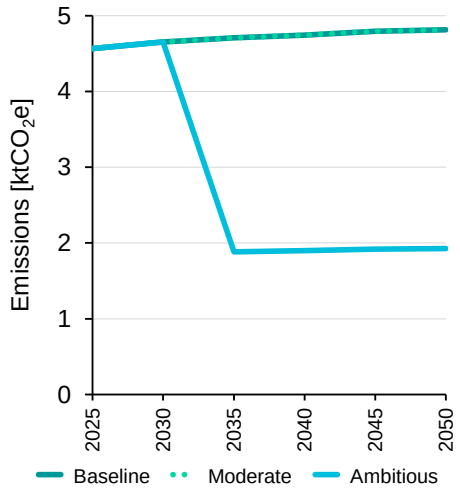
Ambitious: From 2035, an £80-100m investment in a wastewater treatment and AD plant in Guernsey produce 11.0m litres of biomethane each year from 12.5m litres (+/-20%) of wastewater that passes through Belle Greve Wastewater Centre each day. The locally produced biofuel is used in road and marine transport, and for space heating.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Medium**	**Medium**	**12 – 15**	**2.8 – 3.5**	**26 – 32**
			$kgCO_2e/t_{water}$	$£k/kgCO_2e$	£m/year

Considerations & Constraints

A wastewater treatment and AD facility, sited in proximity to Belle Greve, will require a footprint of approximately 4-4.5ha. The resulting anaerobic digestate would be treated to a far higher environmental standard and suitable for discharge to the sea. The treatment process would produce waste heat that could be offered via a District Heating Network (DHN). The States of Guernsey would need to introduce a policy that changes the present policy of discharging wastewater effluent after screening and decide on the level of public and/or private participation in the ownership and operation of a treatment and AD facility.

Outcomes & Benefits



Wastewater treatment plant with AD facility captures and offsets 60% of the existing 4.5 $ktCO_2e$ of wastewater emissions.

60% Reduction in CO_2e

Wastewater treated to a good environmental standard reduces water pollution.

Economic growth and improves the environment

Locally producing 11.0m litres of renewable fuels contributes positively to energy security and self-sufficiency.

Improves Energy security

Enhanced water treatment with AD facility creates employment and economic growth in the energy and water sector.

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Develop policy and strategy	Define and approve a policy of treating wastewater and producing Biomethane fuels for use in transport, residential and business sectors. Identify possible sites and consult with interested participants and community on the principles of local fuel production, using wastewater as a feedstock and discharging the sanitized digestate.	States of Guernsey
B – Pre-feasibility assessment	Undertake pre-feasibility scoping studies, including an assessment of appropriate wastewater treatment with AD technology to handle Guernsey's wastewater volumes.	Guernsey Waste and Guernsey Water
C – Detailed feasibility study	Carry out full feasibility study, which should include site assessment, transport and traffic impact assessment associated with collecting feedstocks and transporting fuels, options for ownership and operating models, product offerings and go-to-market options, and identification of capital and operating expenditures.	Guernsey Waste and Guernsey Water with States of Guernsey approvals
D – Investment case and target operating model	Create the investment case and explore uses of equity and debt, together with the role of public and/or private partnerships.	States of Guernsey
E – Tendering specifications and Procurement	Prepare tender specifications, assess and appoint parties in connection with the construction, commissioning and operating phases.	Guernsey Waste and Guernsey Water
F – Product offerings and go-to-market launch	Establish supply chains for the supply of biofuels for target use cases e.g., uses in road vehicles, marine vessels, and for space heating.	Guernsey Waste and Guernsey Water with private sector participation from Energy Partnership and/or new partners outside of Guernsey's jurisdiction
G – Commission, operate and scale AD production	Commence operations from 2040 and scale the availability of Biofuels within the first six months from date of commissioning.	Wastewater Treatment (Guernsey Water) and AD Plant Operator (may be a private and/or public entity) with appointed Fuel Distributors

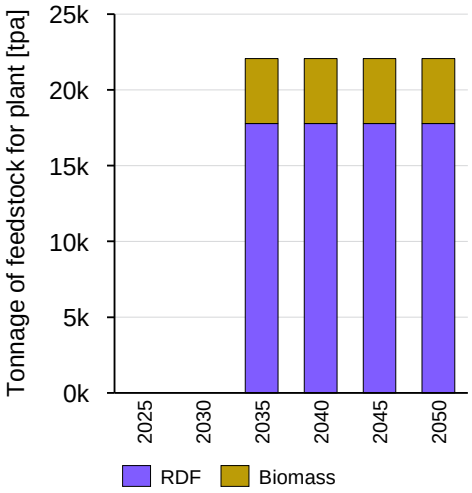
Alignment with UN's Sustainable Development Goals

Clean Water & Sanitation (SDG 6), Affordable and Clean Energy (SDG 7), Decent Work & Economic Growth (SDG 8), Industry, Innovation & Infrastructure (SDG 9), Sustainable Cities & Communities (SDG 11), Responsible Consumption & Production (SDG 12), Climate Action (SDG 13), Life Below Water (SDG 14)

T4.4 Produce BioLPG from Refuse and Biomass in a Gasification Plant

Introduce a gasification plant in Guernsey to derive a syngas from 22,000tpa of Refuse Derived Fuel (RDF) and biomass materials and upgrade it to produce 11.25 million litres of a BioLPG product each year for use in residential and commercial buildings for low carbon space heating.

Decarbonisation Pathways & Timeline



Baseline: No measure is implemented. Refuse Derived Fuel (RDF) and biomass is exported to Scandinavia via the UK for incineration at an Energy Recovery Facility (ERF).

Moderate: Same as Baseline pathway.

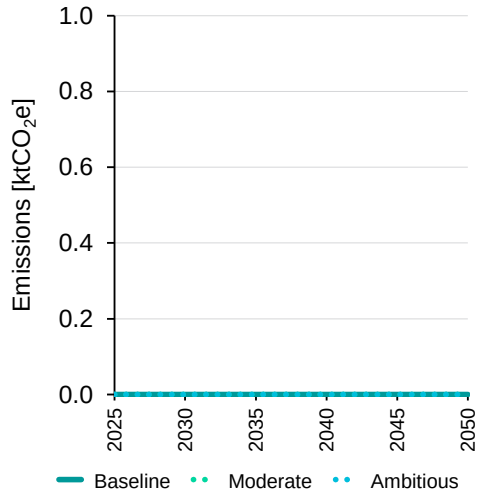
Ambitious: From 2035, a £120-140M investment in a gasification facility in Guernsey produces 11.25M litres of BioLPG each year from 22,067 tpa of RDF and biomass material collected from residential and commercial premises. The locally produced BioLPG is used as a replacement for imported gas that is supplied to residences and businesses via Guernsey's mains gas network and fuel distribution tankers.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**High**	**Low**	**0.9 – 1.1** $kgCO_2e/t_{waste}$	**5.7 – 6.9** $£k/kgCO_2e$	**25 – 31** £m/year

Considerations & Constraints

A Gasification facility would require a footprint of approximately 2-3ha and could be sited at Longue Hogue near to feedstock facilities and gas grid entry points. The resulting hazardous waste would need to be sent to Guernsey's landfill. A proposed development may meet low levels of acceptance and benefits associated with energy security and mitigating risk of carbon taxes should be highlighted. The States of Guernsey would need to introduce a policy that changes the present policy of exporting RDF and Biomass and decide on the level of public and/or private participation in the ownership and operation of the Gasification facility.

Outcomes & Benefits



Using BioLPG can reduce emissions by up to 99% compared to using conventional LPG, however, these benefits are attributed at the point of consumption.

99% reduction in CO_2e

Local waste management eliminates 0.9 $ktCO_2e$ of road and maritime transport emissions outside of Guernsey each year.

Jobs and economic growth

Locally producing 11.25M litres of renewable fuels contributes positively to energy security and self-sufficiency.

Improves Energy security

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Develop policy and strategy	Define and approve a policy of treating RDF and Biomass and producing BioLPG for use in residential and business combustion. Identify possible sites and consult with interested participants and community on the principles of local fuel production, using RDF and Biomass as a feedstock.	States of Guernsey
B – Pre-feasibility assessment	Undertake pre-feasibility scoping studies, including an assessment of appropriate gasification technologies to handle Guernsey's RDF and Biomass waste composition and volumes.	Guernsey Waste
C – Detailed feasibility study	Carry out full feasibility study, which should include site assessment, transport and traffic impact assessment associated with collecting feedstocks and transporting fuels, use of landfill, options for ownership and operating models, product offerings and go-to-market options, and identification of capital and operating expenditures.	Guernsey Waste with States of Guernsey approvals
D – Investment case and target operating model	Create the investment case and explore uses of equity and debt, together with the role of public and/or private partnerships.	States of Guernsey
E – Tendering specifications and Procurement	Prepare tender specifications, assess and appoint parties in connection with the construction, commissioning and operating phases.	Guernsey Waste
F – Product offerings and go-to-market launch	Establish supply chains for the supply of BioLPG for use in residential and business combustion, delivered through the mains distribution network and via fuel distribution tankers, and use of landfill for residual waste created from the gasification process.	Guernsey Waste and Guernsey Energy with private sector participation from Energy Partnership and/or new partners from outside of Guernsey's jurisdiction
G – Commission, operate and scale AD production	Commence operations from 2030 and scale the availability of BioLPG within the first three months from date of commissioning.	Wastewater Treatment and AD Plant Operator (may be a private and/or public entity) with appointed Fuel Distributors

Alignment with UN's Sustainable Development Goals

Affordable and Clean Energy (SDG 7), Industry, Innovation & Infrastructure (SDG 9), Sustainable Cities & Communities (SDG 11)

5.5 Theme 5: Enhance the natural environment and capture emissions

This theme includes several interventions with a focus on adopting sustainable agricultural practices, improving wastewater treatment, and using land, sea and technologies to capture and embed emissions.

T5.1: Improve soil management practices

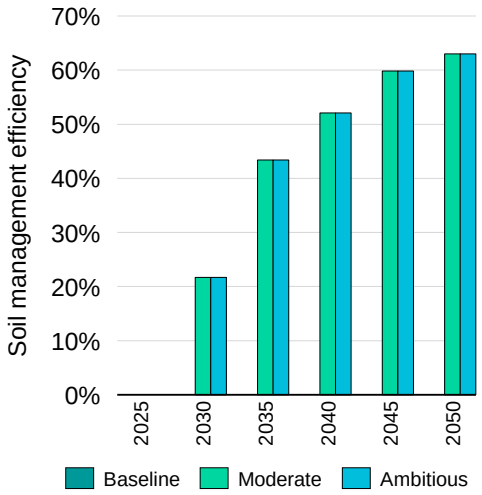
T5.2: Protect woodland, grassland and biodiversity levels

T5.3: Capture carbon from marine vessels

T5.1 Improve Soil Management Practices

This intervention encompasses changes to soil management practices to reduce GHG emissions from agricultural soils (largely N_2O). Example actions included within this are improving synthetic N use in 50% of tilled land and 75% of grassland, and reducing soil compaction in 20% of total tillage and grassland. The full list can be found in the WWF's 2019 report, Delivering on Net Zero: Scottish Agriculture.

Decarbonisation Pathways & Timeline



Baseline: No additional measures to be implemented, as shown on graph.

Moderate: Range of techniques, including improvements to synthetic N use, use of controlled released fertilisers with precision application, reducing soil compaction, and growing legumes in rotation and in grassland. Techniques applied over different phases. Overall, achieves a reduction in emissions of 63% up to 2045.

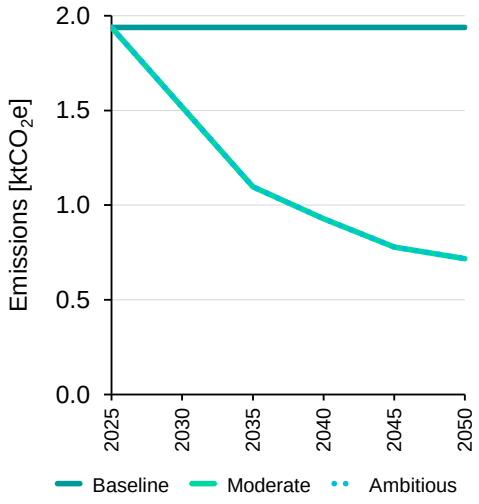
Ambitious: No additional measures to be implemented above those mentioned in the Moderate pathway.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Medium	**Low**	**Medium**	**1.1 – 1.3** ktCO₂e/year	**0.2 – 0.3** £/kgCO₂e	**<1** £m/year

Considerations & Constraints

Farmers may need support, advice, and investment to achieve soil management improvements. Regulatory or fiscal instruments could be linked to N input reduction. Information and profitability will likely drive action, with training availability being crucial. Processes like soil analysis, environmental auditing, and nitrogen planning are needed for implementation and progress monitoring. Costs would require private investment from the agriculture sector, dependent on grant availability. Education and engagement will be needed to overcome preference for historical practices.

Outcomes & Benefits



The suggested measures can reduce emissions by over 1 $ktCO_2e$.

Reductions in nitrate leaching from reduced N input promote improved water quality in surrounding water bodies.

Reduced soil compaction and other benefits from soil management can help to improve soil health, reduce land degradation, and maintain land productivity.

Reduced tillage also has benefits for soil organisms such as earthworms.

63% reduction in CO_2e

Improved soil health and land productivity

Improved water quality

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Engage with farmers and landowners	Engage with farmers and landowners to identify potential for and scale of improvements that could be made. Also to assess current capabilities for implementing changes to practices and identify training and advice requirements.	States of Guernsey with support from research organisations
B – Introduce regulation and fiscal measure to reduce N input	Identify and implement the most appropriate measure for encouraging a reduction in N input.	States of Guernsey
C – Train farmers and landowners	Provide advice and training to farmers on soil management techniques. Support farmers in implementing improvements.	States of Guernsey with support from research organisations
D – Establish monitoring mechanisms	Establish a process for analysing and monitoring progress.	States of Guernsey with support from farmers' unions

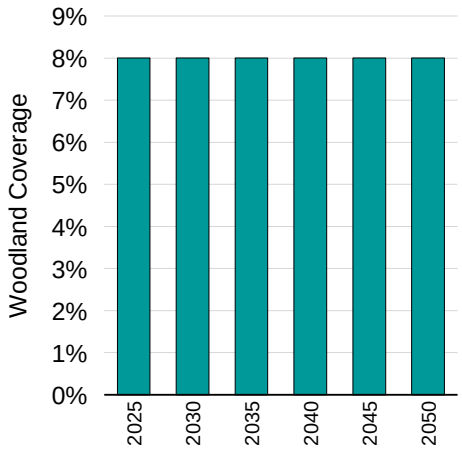
Alignment with UN's Sustainable Development Goals

Zero Hunger (SDG 2), Climate Action (SDG 13), Life Below Water (SDG 14), Life on Land (SDG 15)

T5.2 Protect Woodland, Grassland and Biodiversity Levels

Implement sustainable woodland and grassland management practices that balance ecological, social and economic needs. Protect and manage the existing woodland carbon sinks and associated biodiversity and mandate a principle of net-gain if existing areas of woodland are allocated for development.

Decarbonisation Pathways & Timeline



Baseline: Current levels of woodland retained up to 2050, which covers approximately 8% of Guernsey's land mass.

Moderate: No additional measures are implemented compared to the Baseline pathway.

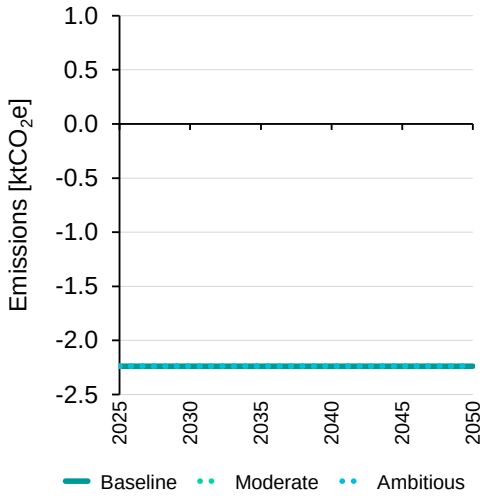
Ambitious: No additional measures are implemented compared to the Baseline pathway.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
High	**Low**	**High**	**7 – 11** tCO_2e/ha	**1.1 – 1.8** $£/kgCO_2e$	**N/A** £m/year

Considerations & Constraints

The effectiveness of carbon sequestration depends on where and how the woodlands and grasslands are established. Factors such as tree species, site conditions, and management practices play a crucial role. Potential conflicts with other land uses, such as agriculture, recreation and housing need to be carefully managed. If urban development requires the removal of woodland, it can take up to 25 years to restore the whole structure and function of woodland for carbon sequestration purposes. If Guernsey could increase woodland coverage from 8% to 15%, this would offset an additional 3 $ktCO_2e$ of emissions each year.

Outcomes & Benefits



Guernsey's trees and grassland absorb 2.2 $ktCO_2e$ of carbon dioxide each year.

Woodland provides habitats for diverse plant and animal species, supporting ecosystems and promoting biodiversity.

Trees filter pollutants and improve air quality, help regulate water flow, prevent soil erosion, and reduce flood risks.

Green spaces enhance mental and physical well-being and contribute to cultural heritage.

2% offset in total CO_2e

Promotes biodiversity and reduces flood risk

Reduces pollution and improves air quality

Associated Actions & Responsibilities

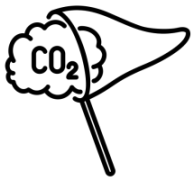
Action	Objectives	Responsibility
A – Enhance sustainable woodland management	Implement comprehensive woodland management plans that incorporate sustainable practices, including reforestation, biodiversity conservation and ecosystem restoration along with the promotion of harvesting techniques that minimize environmental impact.	States of Guernsey
B – Develop and implement training programmes	Offer training programmes to build the capacity of woodland and forestry professionals and workers in sustainable woodland management practices, technological advancements and safety protocols.	States of Guernsey
C – Strengthen monitoring and enforcement	Enhance monitoring systems to track compliance with woodland regulations, including sustainable harvesting practices, protection of sensitive areas and adherence to environmental standards.	States of Guernsey
D – Consider urban forests	Involve local communities and other stakeholders in decision-making processes related to woodland and encourage garden owners and parishes to plant urban forests.	Local Parishes with support from local citizens
E – Consider increasing woodland and circular economy opportunities	Consider allocating land to create new woodland, which might support circular economy opportunities for supplying timber to the construction sector.	States of Guernsey with support from woodland owners

Alignment with UN's Sustainable Development Goals

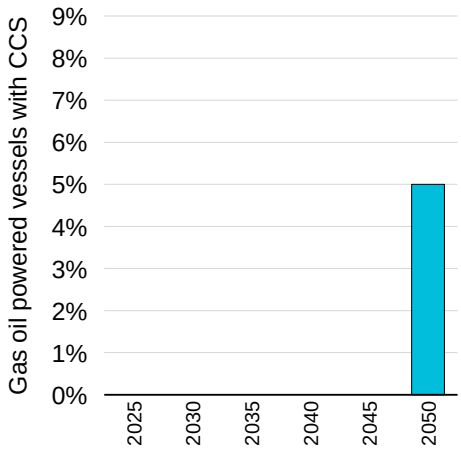
Good Health & Well-being (SDG 3), Reduced Inequalities (SDG 10), Sustainable Cities & Communities (SDG 11), Climate Action (SDG 13), Life on Land (SDG 15)

T5.3 Capture Carbon from Marine Vessels

Pilot projects are currently underway to test the implementation of carbon capture technology onboard marine vessels. This intervention covers the use of stacks to directly capture CO_2 from fuel combustion on marine vessels. The captured carbon is stored and transferred when the vessel is docked.



Decarbonisation Pathways & Timeline



Baseline: No additional measures are implemented, and consumption grows in line with population.

Moderate: No additional measures are implemented compared to the Baseline pathway.

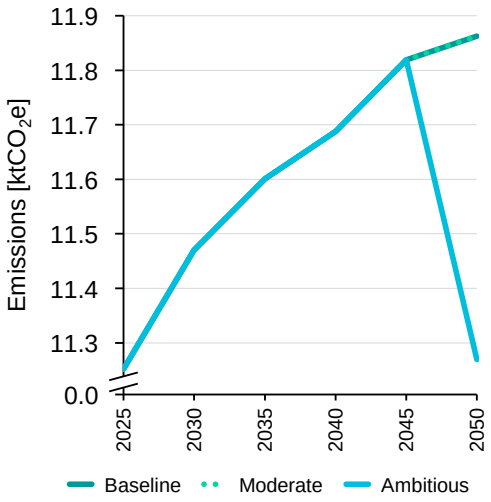
Ambitious: 5% reduction in emissions from gas oil used in marine vessels due to implementation of carbon capture and storage (CCS) from 2045.

Maturity	*Complexity*	*Acceptance*	*Carbon Saving*	*Expenditure*	*GVA*
Low	**High**	**Medium**	**0.5 – 0.7** ktCO2e/year	**3.8 – 4.6** £/kgCO2e	**<1** £m/year

Considerations & Constraints

Investment in infrastructure is needed for carbon storage, transport, and processing, both on vessels and at ports. While CCS technology is used on-land, more research is needed for marine integration. Costs, incentives, and/or regulation will be key factors. Training and skills development in the technology are required. The technology is in its infancy with high, but undisclosed, upfront costs. This intervention is not feasible until ~2040s, except for one-off trials. Expenditure and cost savings are from an OGCI feasibility study. Carbon savings represent 2045 savings when the intervention is introduced.

Outcomes & Benefits



Emissions captured by domiciled vessels within Guernsey's jurisdiction could be reported as an offset, which will contribute towards achieving carbon neutrality.

Markets could develop for products of CCS processes, such as limestone or pure CO_2, with economic benefits.

5% reduction in CO_2e

Carbon offsetting measure

Additional sources of income

Associated Actions & Responsibilities

Action	Objectives	Responsibility
A – Research feasibility and scope	Consult existing research and potentially supplement with additional research on the feasiblility of implementing CCS on marine vessels, and the options for its use.	Guernsey Ports
B – Introduce regulatory and fiscal instruments	Identify and implement most appropriate measure or combination of measures for encouraging use of CCS on marine vessels.	Guernsey Ports
C – Engage with vessel owners	Provide information, advice and training to vessel owners on potential use of CCS on vessels. Raise awareness in the industry more generally on environmental issues and marine users' responsibilities.	Guernsey Ports
D – Develop skills to work in this area	Support the training of workers to install and maintain technology for CCS. Also consider bringing this expertise in from elsewhere to supplement on-Island training.	Guernsey Ports

Alignment with UN's Sustainable Development Goals

Industry, Innovation & Infrastructure (SDG 9), Climate Action (SDG 13), Life Below Water (SDG 14), Life on Land (SDG 15), Partnerships for the Goals (SDG 17)

5.6 Theme 6: Engage and incentivise stakeholders

A programme of communication, engagement and education will be critical to securing cooperation from citizens and businesses, which in turn will build a widely shared environmental consciousness amongst stakeholders that choose to change their behaviours and choices, rather than feeling that government is forcing unnecessary change and imposing increased costs on citizens and businesses. This theme includes several interventions with a focus on communication and education to achieve buy-in from citizens and businesses, and financial incentives and disincentives to encourage action and positive change.

- Communicate and engage with citizens and businesses
- Introduce incentives and disincentives

T6.1: Communicate and Engage with Citizens and Businesses

When engaging with citizens and businesses, it will be important to make 'net zero' relatable, reach diverse audiences, and encourage collective action. A well-coordinated, ongoing stakeholder engagement and communication plan is needed, and the plan should outline who to engage, the benefits of engagement, the key messages, the level of participation needed, and the frequency and methods of engagement.

Communication should educate stakeholders about the importance of emission reduction, the consequences of inaction, and the opportunities and benefits associated with achieving net zero. Engagement should gather diverse opinions and feedback from citizens and businesses via consultations, focus groups, townhall presentations, and encourage stakeholders to actively participate in interventions, make new choices, and change behaviours.

Some strategies for the States of Guernsey to consider are set out below:

When engaging with citizens and communities:

- Ensure that diverse viewpoints are captured and that everyone feels they can be a part of solving the challenge.
- Use consultations, workshops and public forums to seek input on climate policies and adaptation measures.
- Educate citizens about net zero and the steps they can take, and consequences of not acting.

When engaging with businesses:

- Continue to engage with the Energy Partnership.
- Collaborate with businesses understand their net zero goals, priorities and challenges, and test ideas.
- Facilitate connections and discussions between businesses and organisations that can help them to develop their net zero strategies and plans.
- Lead by example to demonstrate how the States of Guernsey is acting on emissions e.g., buildings, fleets, services etc.

Considerations for inclusion in a communication strategy:

- Transparently and clearly communicate net zero ambitions, progress, and challenges.
- Share net zero targets and success stories through public announcements.
- Use storytelling narratives to convey urgency and benefits.

Communication and engagement will be an ongoing process, and regular updates and adaptability will be essential for establishing and maintaining cooperation from stakeholders and momentum toward achieving net zero.

T6.2: Incentives and Disincentives

The most significant barrier to achieving the required levels of electrification and adoption of renewable fuels will be reducing or removing the differential cost compared to conventional alternatives. Installing heat pumps into existing buildings with fossil-fuel heating systems, together with necessary alterations and energy efficiency measures, is both costly and disruptive, and necessitates grants from governments to reduce the differential cost that currently exists. Additionally, the limited availability of renewable fuels means that they are generally more expensive, and will therefore require action on fuel duties to reduce the price differential. A coordinated approach to introducing incentives and disincentives will therefore be required, and targeted in an effective manner to best achieve the desired outcomes in an affordable manner.

To navigate effectively toward achieving net zero, incentives and disincentives serve as powerful tools for guiding jurisdictions, and influencing the behaviours and decisions of citizens and businesses within jurisdictions. The strategic application of incentives and disincentives is critical in achieving desired outcomes and avoiding unintended consequences. Furthermore, their affordability is a key consideration.

Incentives can be broadly classified into three categories, and may include:

- **Motivation:** These incentives aim to promote positive actions by making sustainable choices more appealing. Financial support, tax breaks, and grants may be leveraged to motivate individuals, businesses, and industries to change their behaviours and adopt low-carbon technologies.
- **Innovation:** Incentives in this category are designed to spur innovation, and may be achieved through funding research and development (R&D), offering R&D grants for clean energy solutions, or issuing green bonds to finance carbon reduction interventions or infrastructure projects.
- **Market Signals:** These incentives involve the development of policies that prioritize green initiatives that creates demand for sustainable products and services and attracts investors because they see opportunities to invest for favourable returns at low risk.

On the other hand, disincentives are employed to discourage inaction and mandate necessary changes, and may include:

- **Cost of Emissions:** Carbon pricing mechanisms, such as taxes or cap-and-trade systems, assign a cost to emissions that are set to increase over time, and businesses may face financial penalties for exceeding set limits.
- **Regulations:** Introducing strict rules, including emission limits and targets to achieve efficiency standards, guide behaviour and penalties for non-compliance could be introduced to ensure businesses remain accountable.
- **Behavioural Nudges:** Measures such as congestion pricing or peak-hour charges are used to encourage eco-friendly choices, and gently encourage behaviour toward sustainability options.

Whilst incentives do require governments to allocate capital for investment and/or accept reduced revenue receipts, it may be possible to use disincentives to fund incentives partially or wholly. Further, a strategy and journey that involves leading with incentives before applying disincentives may need to be considered.

Guernsey's net zero goal requires emission reduction across all sectors. Publicly owned companies under the States of Guernsey Trading Group and States' Trading Supervisory Board may not need incentives or disincentives in areas like electricity, ports, waste, and water. However, to alter behaviours and choices related to active travel, motorised road and marine transport, heating buildings, and farming, incentives and disincentives will be essential.

Table 12 summarises possible incentives and disincentives that could be introduced individually or as a coordinated package to reduce emissions and work towards achieving net zero.

Table 12: Possible incentives and disincentives that could be introduced in connection with the proposed interventions

Sector	Incentive	Disincentive
Agriculture	Help farmers monitor their emissions and understand the positive impact of positive actions. Offer grants that remove the price differential between electric farm equipment and conventional alternatives. Offer subsidies to farmers that implement regenerative farming techniques to capture emissions in soil.	Phase in a carbon tax per head of livestock to encourage improvements in production yields.
Business	Help businesses monitor their emissions and understand the positive impact of positive actions. Offer grants to small businesses to introduce electric heating into existing premises.	Phase in a carbon tax on the use of ICE plant and equipment. Phase in a carbon tax on overnight stays to contribute towards carbon reduction interventions. Require new business premises to have electric heating. Ban the availability of conventional fuels for heating and processes.
Electricity	Expedite planning approvals on necessary upgrades to the electricity distribution network to enable electrification	Phase in a carbon tax on the use of conventional fuels in standby generation.
Fuels	Introduce a policy that targets the use of 100% renewable fuels for heating, vehicles and maritime, and a principle of producing fuels locally. Remove fuel duty on renewable fuels to reduce price differential compared to conventional fuels - for all business, residential, transport (road, maritime) uses.	Increase fuel duty on conventional fuels to reduce price differential compared to renewable fuels - for all business, residential, transport (road, maritime) uses. Introduce a ban on the use of conventional fuels for all business, residential, transport (road, maritime) uses.
F-gases		Phase out the use of hydrofluorocarbons (HFCs) across all sectors.

		Introduce a ban of imported goods that contain hydrofluorocarbons (HFCs).
Land & Forestry	Establish an urban forest scheme to encourage community tree planting in gardens, towns and parishes.	Protect existing woodland from development.
Residential	Help homeowners monitor their emissions and understand the positive impact of positive actions. Introduce an EPC incentive into the calculation on the value of Tax on Real Property (TRP) levied on dwellings. Offer grants to homeowners that introduce electric heating into existing dwellings.	Introduce an EPC disincentive into the calculation on the value of Tax on Real Property (TRP) levied on dwellings. Require new dwellings to have electric heating. Ban the availability of conventional fuels for heating.
Transport (Aviation)	Offer grants that remove the price differential between electric aircraft and conventional alternatives.	Introduce a distance-related carbon tax per passenger on commercial aircraft that use conventional fuels Introduce a ban on short-distance commercial flights e.g., between Channel Islands. Phase in targets for the use of Sustainable Aviation Fuels.
Transport (Maritime)	Offer grants that remove the price differential between electric passenger ferries and conventional alternatives.	Phase in a carbon tax on visiting cruise ship passengers to contribute towards carbon reduction interventions.
Travel Modal Shift	Increase the level of subsidy on public transport or offer free public transport. Allocate dedicated and free parking spaces in town centres for use by shared EVs.	Introduce dynamic tolls for car journeys, with exemption for shared EVs. Introduce car parking charges, with exemption for shared EVs.
Transport (Vehicles)	Remove fuel duty on renewable fuels to reduce price differential compared to conventional fuels. Introduce a scrappage scheme to reduce cars on Guernsey's roads.	Increase fuel duty on conventional fuels to reduce price differential compared to renewable fuels. Introduce a vehicle tax that disincentivises polluting vehicles and more than one vehicle per registered address. Introduce tariffs on all cars that are imported, which might initially disincentivise ICE vehicles. Introduce a ban on the import of ICE vehicles. Introduce a quota on the maximum number of cars permitted on the Island.
Waste	Allocate sites for AD and Gasification plants, and expedite planning decisions on plants and pipelines.	Ban the export of waste to other jurisdictions.

DECARBONISATION PATHWAY OPTIONS FOR THE ISLAND OF GUERNSEY

6.0 Conclusions & Recommended Pathway

Decarbonisation is a collective endeavour that necessitates all jurisdictions and individuals to reduce their consumption and waste, invest in energy efficiency and electrification, and switch to using alternative renewable fuels. Regardless of how a jurisdiction or individual perceives their emissions impact, only united action can bring about the necessary change to curb the severe effects of global climate change. Achieving net zero emissions will be challenging to achieve in Guernsey, however all jurisdictions face this same challenge. The International Energy Agency expects that almost half of the reductions in global emissions in 2050 will need to come from technologies that are currently at the demonstration or prototype phase.

Since 1990, Guernsey has reduced its emissions by 46.5%. The largest reductions occurred due to decarbonisation of electricity supply, reduced use of fossil-fuels for domestic, commercial and industrial combustion, reduced fuel consumption in vehicle transport, and reduced use of landfill for waste. Over the same period, emissions increased in connection with agricultural activity and use of F-Gases.

Guernsey has a target to achieve net zero emissions by 2050 and, by 2030, reduce emissions by 57% compared to the levels recorded in 1990. Based on the results of this pathway development study, Guernsey can realistically achieve its interim target of reducing emissions with the Baseline pathway, however the Ambitious pathway with additional measures will be required to achieve net zero emissions.

To achieve net zero, the most significant undertaking will be rapidly reducing the use of conventional fuels across all sectors, particularly in transport, residential, and business sectors, and key to achieving this lies in electrification, which additionally necessitates the decarbonisation of Guernsey's electricity supply. However, electrification is not the only answer. Reducing energy demand, improving energy efficiency and increasing the availability and adoption of renewable fuels also plays a positive role in reducing emissions, and can have a positive impact earlier in Guernsey's decarbonisation pathway.

The developed pathways aim to present a clear and actionable direction toward achieving net zero, which means they currently fall short of achieving net zero within the considered time horizon. Fully implementing the developed Baseline, Moderate or Ambitious pathways could reduce Guernsey's emissions by 66%, 91% or 96%, respectively, up to 2050 compared to the levels recorded in 2022. All pathways require significant changes to be implemented and adopted, and can be achieved without needing to curtail lifestyles and economic activities. However, Guernsey's constrained space does pose a challenge to achieving net zero emissions, which needs to balance reduced emissions from human activities with offsetting emissions through actions achieved such as tree planting or employing technologies that can capture carbon before it is released into the air.

Recommended pathway

To achieve net zero emissions, it is recommended that Guernsey adopts the Ambitious pathway. By proceeding with the interventions that are proposed in the Ambitious pathway, Guernsey can enact immediate and positive action, and, in future, review the suitability of emerging technological advancements, such as hydrogen and carbon capture technologies, as well as the availability and suitability of external offsetting measures.

The general path to achieving net zero will be a multifaceted one, requiring cooperation, commitment, investment, and the timely consideration and implementation of continued innovation change. After agreeing a decarbonisation strategy and roadmap of interventions, together with the level of implementation and adoption, and timelines, consider the following as early next steps:

- **Goal Setting for Sectors:** To achieve Guernsey's net zero target, set targets for reducing emissions in each sector e.g., business, residential, transport etc.
- **Policy Frameworks:** Create a comprehensive policy framework that includes regulations, incentives and market mechanisms, and consider emission pricing policies for each sector.
- **Stakeholder Engagement:** Involve industry, academia, NGOs and citizens in the strategy development process, and gather diverse perspectives and expertise.
- **Research and Innovation:** Promote research and development for low-carbon technologies, and encourage innovation in energy, transportation, and other sectors, and in collaboration with the Energy Partnership.
- **Sector-Specific Strategies:** Develop tailored strategies for different sectors (e.g., industrial decarbonisation, renewable energy, travel), and address unique challenges and opportunities in each sector.

- **Sector Coupling Strategies:** Additionally develop tailored strategies that cross-cut several sectors to enable whole-economy decarbonisation and circular economy opportunities (e.g., interventions for anaerobic digestion and gasification plants cut across agriculture, business, residential, transport and waste sectors).
- **Infrastructure Investment:** Allocate and facilitate resources for building sustainable infrastructure (renewable energy projects, public transportation, etc.), which should involve participation from private investors, businesses and citizens as well as public sector investment.
- **Monitoring and Reporting:** Establish mechanisms to track progress and adjust strategies as needed, and regularly report on achievements and challenges, and additionally monitor the suitability of newly emerging technologies.

Appendix A: Excluded Interventions

To reduce emissions and work towards achieving net zero, the developed pathways will require Guernsey to implement significant changes, and this will require Guernsey's citizens and businesses to make different choices and alter behaviours. The aim of the developed pathways is to show a tangible journey towards achieving net zero, using proven interventions that can also enhance Guernsey's lifestyle, character and economy. The process of selecting interventions used several criteria to determine their suitability, primarily their potential impact on GHG emission reduction, but notably also the ease of execution and the maturity of the associated technology. Other interventions were considered for possible inclusion in the developed pathways, however these were excluded on the basis that they may be currently unproven or impractical to achieve, or could unreasonably impose on the choices and freedoms of Guernsey's citizens and businesses, and which could be detrimental to Guernsey's lifestyle, character and economy. Table 13 highlights the interventions that were excluded from the developed pathways, including the reasoning.

Table 13: Excluded interventions and justification

Sector	Excluded Intervention	Rationale for Exclusion
Agriculture	Increase Clover-Grass Mix	Difficulty to assess impact on emissions and biodiversity
	Ban cattle	Detrimental to economy and food security
	Encourage a vegan diet	Detrimental to consumer choice and freedoms
Business	Carbon Capture & Storage	Low impact due to low levels of industrial activities
Residential	Digital Optimisation and Automation	Implementation constraints, e.g. citizens' data privacy
	Interactive Communication and Gamification	Effort to benefit ratio too high
Electricity Supply	Hydrogen Production using Increased Renewable Generation	Explored in the Electricity Strategy; No emissions benefits over imported hydrogen
F-Gases	Cooling Network to reduce use of Refrigerants	High complexity; Partially addresses by other interventions, such as improved building standards
	Retrofit industrial refrigeration systems and air conditioning units	Low emission reduction impact with a high lifecycle cost
Land & Forestry	Increase Afforestation	Ranked as not feasible during workshop
	Growth of Crop for Biofuel	No net GHG emissions benefit
	Growing seagrasses	Explored in detail and offers relatively small CO_2e offsetting potential. Assuming up to 15% of Guernsey's coastline could be used for planting seagrasses, and assuming a 100-metre width, 0.05 $ktCO_2e$/year of emissions could be sequestered.
Transport	Car-free days	Ranked as not feasible during workshop
	Personal Carbon Budget and Trading Scheme	No reference case studies to model reduction impact
	Electric Shuttle Flights to Channel Islands	Low technology maturity
	Hydrogen-powered marine vessels	Ammonia has higher energy density than hydrogen; Higher potential retrofit costs compared to ammonia
	Imposing limits on car ownership	Detrimental to consumer choice and freedoms
	Imposing limits on flights	Detrimental to consumer choice and freedoms
	Rail tunnel to France via Jersey	Assumed commercially unviable
Waste Management	Landfill Gas Capture	Benefit elapsed due to historic closure of landfill cells
	Reduce Import of Packaged Goods	Ability to enforce this upon exporting jurisdictions
	Garden waste feedstock for Gasification process	Removes a local source of compost, which would increase demand for imported alternatives
	Continue discharging screened effluent to sea	Excluded on environmental grounds. Emissions reported in the GHG inventory assume biological treatment, which does not occur. Reported emissions could be reduced by 4.5 $ktCO_2e$/year in the Baseline and Moderate pathways, and 1.5 $ktCO_2e$/year in the Ambitious pathway.

Appendix B: Key Assumptions

Scope and Delivery

It was agreed that the aim of this work was to model Guernsey's scope 1 and 2 emissions and to comment on the potential impact on scope 3. Scope 1 and 2 emissions are more clearly defined and are sources which Guernsey has more control and influence over relative to scope 3. Quantifying scope 3 sources therefore has a much higher associated uncertainty compared to scope 1 and 2 emissions.

However, States of Guernsey recognise the impact of scope 3 emissions and has stated that Guernsey aims to not increase scope 3 emissions by pushing existing scope 1 emissions off-island as an initial approach to delivering net zero[50]. Therefore, this work acknowledges key scope 3 sources and qualitatively outlines how Guernsey should consider its influence over scope 3 sources when decarbonising.

Model and Methodology

To facilitate modelling, the following assumptions were made:

- The 33 distinct sources of f-gas emissions were aggregated and allocated to 'Business' and 'Residential' sectors as the assumptions and interventions applied for all scenarios encompass all f-gases sources.
- Process emissions from cream consumption is allocated under Industrial Processes in the inventory – as this is a negligible source of GHG emissions, it was allocated to the Business sector for this piece of work.
- The projected emission factors were assumed the same as 2022 aside from road transport which decreased from 2022 onwards.
- Emissions savings were calculated across varying timeframes for each intervention to account for differing rates of decarbonisation, e.g. 10% reduction in fuel use between 2030 and 2040 and then 20% between 2040 and 2050. However, emission savings within the timeframes were assumed to be linear. For example, the impact of a 10% reduction in fuel use between 2030 and 2040 would be applied evenly across the decade.
- Some interventions were assumed to start in a single year, rather than be phased in over several years e.g. operation of an anaerobic digestion plant. In these cases, the emissions savings are instantaneous.
- In the ambitious scenario, the interventions on anaerobic digestion and gasification result in a higher supply than demand. Due to the nature of the Carbon Scenario Model, if left unaddressed this causes the model to show negative emissions from emission sources which is not feasible. To correct this, negative emissions are set to zero (excluding land use change where carbon removals can and do occur) with a justification that the surplus biofuel generated would be exported off-site.
- Energy savings were calculated based on the type of intervention. For energy efficiency interventions, the savings yielded from the anticipated improvements were based on average consumption and energy/fuel prices. For modal switches of transport, the calculation considered the energy saved from eliminating the usage of a typical vehicle and its associated fuel type. The electrification and replacement of fuel interventions considered the price and energy requirement differential between the main applications within the proposed measures. For energy and fuel generation, the energy savings were associated with the production value of the unit and the anticipated quantity of annual supply.
- GVA values were estimated based on the following methodology:
  - A defining output metric was determined for each of the listed interventions in the report. For example, for 'Promote and Encourage Active Travel' the length of kilometres of cycle lanes to be installed was chosen. For interventions where these metrics were intangible, investment values were used instead.
  - A jobs-per-metric factor was determined for each of the interventions (e.g. FTE per km of cycle lane installed) and multiplied by the interventions' output metrics.
  - The resulting number of FTE jobs were distributed across 20 employment sectors, including Agriculture, Automotive, Aviation, Construction, Customer Service, Design, Energy, Engineering, Environmental, Legal, Logistics, Manufacturing, Maritime, Marketing, Public Sector, Safety, Sales, Technology, Transport and Urban Planning, and an associated annual remuneration value per worker was set based on Guernsey's Annual GVA and GDP Bulletin.
  - The annual GVA contribution was determined by multiplying the sector specific jobs by their respective remuneration values and the implementation period of the corresponding intervention.

[50] States of Guernsey Climate Change Policy & Action Plan

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24 March 2025

THE STATES OF DELIBERATION
of the
ISLAND OF GUERNSEY

COMMITTEE *FOR THE* ENVIRONMENT & INFRASTRUCTURE

PATHWAY TO NET ZERO

Dear Sir,

Preferred date for consideration by the States of Deliberation

In accordance with Rule 4(3) of the Rules of Procedure of the States of Deliberation and their Committees, the Committee *for the* Environment & Infrastructure requests that the 'Pathway to Net Zero' Policy Letter be considered at the States' meeting to be held on 30th April 2025.

This policy letter relates to the Government Work Plan workstream "Free Trade Agreements & Related International Obligations" as, having had the Paris agreement extended to Guernsey in December 2023, the work undertaken provides for Guernsey's approach to meeting the Paris Agreement requirements.

Yours faithfully,

Deputy Lindsay de Sausmarez

President
Committee *for the* Environment & Infrastructure

cc: propositions@gov.gg