# *Guernsey Hydrocarbon Demand Forecast*

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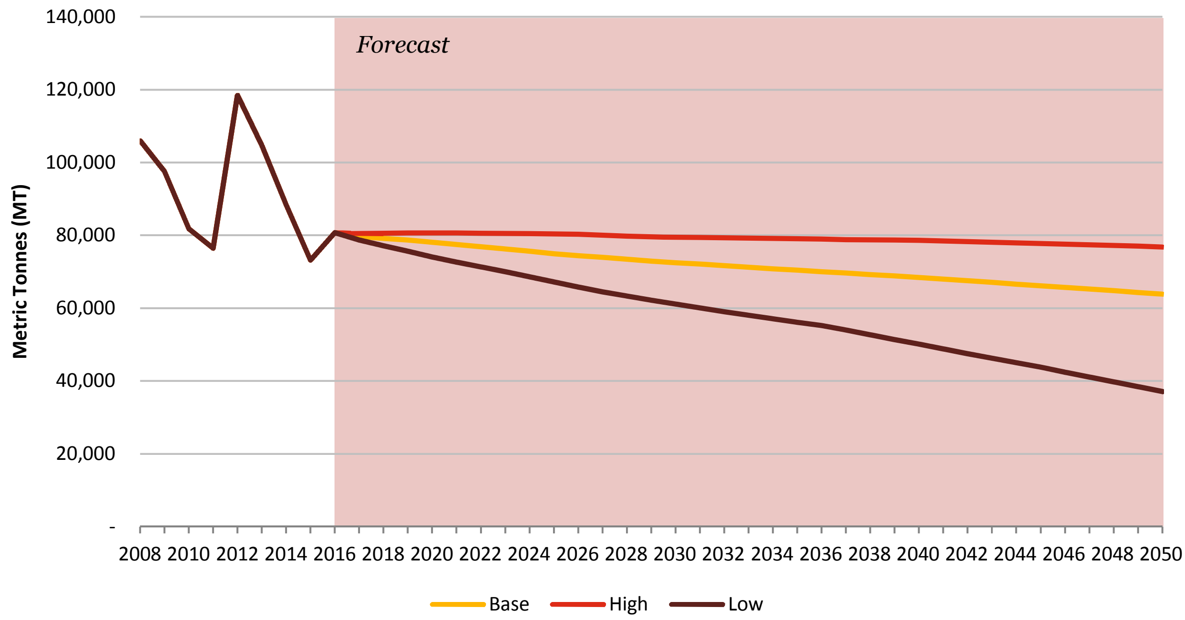
# 1. Executive summary

## 1.1 Executive summary

We believe that demand for hydrocarbon demand on Guernsey is most likely to decrease over the forecast period. Our base case shows a volume decline of -21% in total between 2016 and 2050, our low case a decline of -54% while our high case is essentially flat.

**Figure 1.1: Guernsey hydrocarbon demand by scenario, 2008-2050**




Note that heavy fuel oil (HFO) demand for Guernsey Electricity (GEL) is the primary driver of historical volatility.

In aggregate, the forecast decline in demand is the net impact of the following key factors:

- Broadly flat population forecasts
- An economy that is forecast to grow slowly but without any structural changes in the mix of economic activity conducted on the island
- Increases in fuel efficiency across most segments, in particular the road transport and heating markets
- Gradual electrification in some segments, most notably the uptake of electric vehicles (EVs)

Our base case shows a slower rate of decline than experienced historically given that efficiency improvements are unlikely to be maintained at the same rate over such an extended period.

The declining trend is in line with current industry expectations for hydrocarbon demand in developed economies, which is expected to trend down after reaching 'peak demand' in 2007.

Forecasting over such a long period inevitably contains significant uncertainty. The largest uncertainties in our forecast are:

- The rate of uptake of EVs. Absent any government policies, uptake will be due to market forces such as consumer preferences and product pricing/ performance. In a small market such as Guernsey, consumer attitudes towards EVs is likely to be the dominant factor.
- GEL's demand for HFO for on-island generation. The proportion of electricity that is generated on island, rather than supplied via interconnector, is influenced by factors

including government policy, fuel prices, the reliability of the current interconnector, and the possibility of new interconnectors. This means that a wide range of potential scenarios is possible. We have presented the impact of an interconnector failure in section 3.3.
- The relative shares of heating oil, LPG and electricity for residential and commercial heating. The share of each fuel has been stable historically but over the forecast period a range of factors could have an impact, in particular the relative pricing of each alternative.

Our forecast scenarios are all based on existing States of Guernsey policies. We note that changes in policy could have a significant impact on the use of hydrocarbons on the island, potentially reducing hydrocarbon demand faster than shown in our low case scenario. Policy could, for example, be used in the following areas:

- To reduce road transport fuel demand by incentivising the uptake of fuel efficient and/or EVs, across the private, commercial and public sectors
- To reduce HFO used for electricity generation by investing in, or incentivising, renewable energy generation. Guernsey is potentially suitable location for wind, marine or solar power generation.
- To encourage a switch away from hydrocarbons used for domestic energy requirements.

# 2. Introduction and methodology

# 2.1 Introduction

## 2.1.1 Demand forecast background

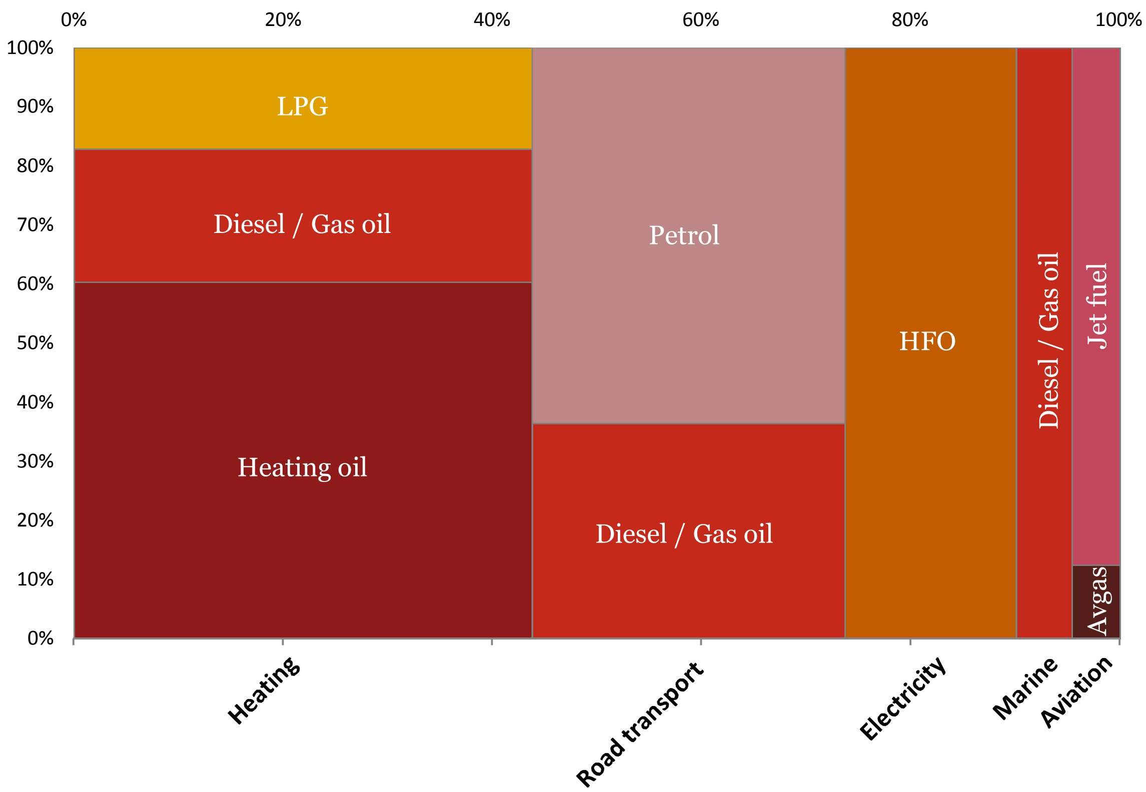
This report forms part of the Guernsey Hydrocarbon Programme. The aim of this programme is to ensure a safe, secure and reliable supply of hydrocarbons to support the island's energy needs. This report seeks to forecast the volume of hydrocarbons that the island will need through to 2050, in order to inform the development and evaluation of potential options.

The island and its community consumes a variety of hydrocarbons for road transport, heating, aviation, marine and electricity generation markets. The fuels consumed include Liquid Petroleum Gas (LPG), petrol, diesel/gas oil, aviation gasoline (avgas), heating oil/kerosene, jet fuel, and HFO. All gas is imported to Guernsey as LPG. The mapping of fuels to their markets is shown in the table below.

| Fuel | Markets |
|---|---|
| Petrol | Road transport |
| Diesel / gas oil | Road transport, heating, marine |
| Aviation gasoline | Aviation |
| Heating oil / kerosene | Heating |
| Jet fuel | Aviation |
| HFO | Electricity generation |
| LPG | Heating |

Heating took up the greatest proportion of hydrocarbon imports in 2016, followed by road transport, electricity, marine and aviation. The split by use and hydrocarbon is shown below in Figure 1.1.

**Figure 2.1: Guernsey hydrocarbon fuel imports by type and use case, 2016**




*Source: Guernsey Customs & Excise*

This report seeks to forecast hydrocarbon demand by market, from 2016 to 2050. Forecasting over such a long period is of course highly uncertain, so we present our methodology and assumptions carefully so that readers can understand the judgments we have made. We also present some alternative scenarios as well as some discrete events that could have an impact on hydrocarbon demand.

### 2.1.2 Underlying concepts

Our demand forecast has been developed using four underlying concepts:

**1. Focus on drivers of demand, rather than an extrapolation of historical data.** As we demonstrate in section 2.2, patterns of hydrocarbon demand have changed significantly over the last decade, and therefore an extrapolation of past demand is not necessarily the best guide to the future. We have therefore sought to understand the underlying drivers of demand in each market and made assumptions – based on third party data where possible – about how these drivers are likely to develop. Examples of such drivers include population, vehicle fleet composition, fuel efficiency, airline fuelling strategies, etc.

**2. Using international benchmarks where appropriate**, with an understanding of the Guernsey context. There are more benchmarks and forecasts available for larger markets (specifically the UK and France) than there are for Guernsey. Where appropriate, we have used data from respected sources in these markets (for example, forecasts for the rate of uptake of EVs), but we also recognise that in many areas the dynamics of the Guernsey market are unique.

**3. Stakeholder engagement for data gathering and greater assurance.** We have interviewed, and received information from, a number of major hydrocarbon users and other stakeholders in Guernsey. This is important not only for data gathering, but also to add assurance on the inputs, calculations and outputs to our model. Stakeholders that have inputted views and information include:

- States of Guernsey Policy & Resources Committee
- States of Guernsey Committee for the Environment & Infrastructure
- States of Guernsey Committee for Economic Development
- Guernsey Gas
- Guernsey Electricity
- Guernsey Airport and Harbours
- Guernsey Harbour Pilots
- RUBiS Fuels
- CI Fuels
- Aurigny
- Condor Ferries
- Jamesco
- HSE
- Port users group

**4. Scenario analysis and event 'toggles'.** In order to reflect the range of variables and uncertainties inherent in forecasting over such a long period, we have used scenarios and 'toggles' to reflect a range of possible outcomes.

We have developed three scenarios for forecast demand. These represent alternative but realistic scenarios based on current information and existing States of Guernsey policy.

- The 'base case' scenario represents our view of the median outcome, i.e. the forecast where the eventual outcome is equally likely to be greater or less than the forecast.

- The ‘low case’ scenario shows how the forecast would be different with an alternative, but still realistic, set of assumptions, that together drive a lower level of demand. It is not intended to represent a ‘minimum’ demand case.
- The ‘high case’ scenario shows how the forecast would be different with an alternative, but still realistic, set of assumptions, that together drive a higher level of demand. It is not intended to represent a ‘maximum’ demand case.

In addition, there are a number of discrete events that have the potential to impact hydrocarbon demand but that are not easily forecastable. In order to illustrate their potential impact we have created a set of ‘toggles’ that can be overlaid on the forecasts to show what might happen if these discrete events occurred. These include:

- A particularly cold winter, which would increase demand for heating fuel
- The construction of a second electricity interconnector on to the island
- The temporary failure of an interconnector, for an illustrative period of 9 months

Our forecasts are based on current States of Guernsey policies. We have therefore not considered or modelled the impact on future hydrocarbon demand of any changes to government policy. We note, however, that in other markets government policies can have a marked impact on hydrocarbon demand, for example in encouraging the uptake of electric or hybrid vehicles, home insulation, distributed generation or renewable power generation. We are not aware of any current States of Guernsey policy that is focused on driving uptake in these areas. Absent any further policy changes, the rate of uptake on the island will be due solely to market forces.

# 2.2 Global hydrocarbon demand context

## 2.2.1 Global hydrocarbon demand

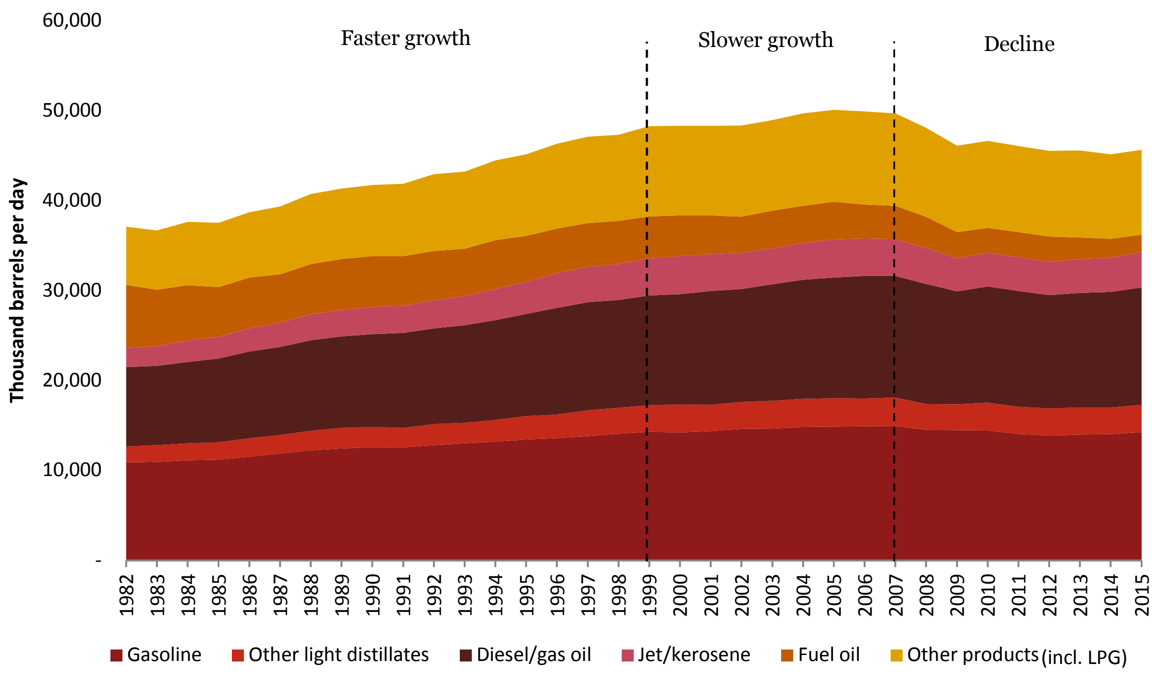
As a starting reference, we have looked at historic and forecast hydrocarbon demand in larger developed economies where more data and research is available.

Hydrocarbon demand is the net impact of the following three underlying factors:

- **Economic growth**, as typically measured by Gross Domestic Product (GDP). A growing economy implies a growing population and/or increasing levels of wealth, both of which would cause an increase in hydrocarbon consumption driven by factors such as growth in car ownership, increased trade, increased travel and increased housing.
- **Energy efficiency**. An economy's energy efficiency can be improved by a range of factors such as engine technology, heat insulation and consumer awareness.
- **Substitution by alternative energy sources**. Hydrocarbons are a source of energy that can be substituted by, for example, nuclear power generation or renewable energy. Note that EVs substitute petrol/diesel for electric power, which may or may not be generated using hydrocarbons.

Over the last 30 years, total liquid hydrocarbon demand in developed markets has been characterised by three main phases, each of which showed a different net balance of the above three factors.

**Figure 2.2: Total OECD oil demand by product, 1982-2015**




*Source: BP Statistical Review of World Energy (2016)*

| | 1982-1999 | 2000-2007 | 2008-2015 |
|---|---|---|---|
| **OECD oil demand** | 1.6% p.a. | 0.4% p.a. | -0.7% p.a. |
| **OECD GDP growth** | 3.1% p.a. | 2.4% p.a. | 1.2% p.a. |

Prior to 1999 demand grew strongly at about half GDP growth. Western economies were growing, and car ownership, international trade and air transport were increasing.

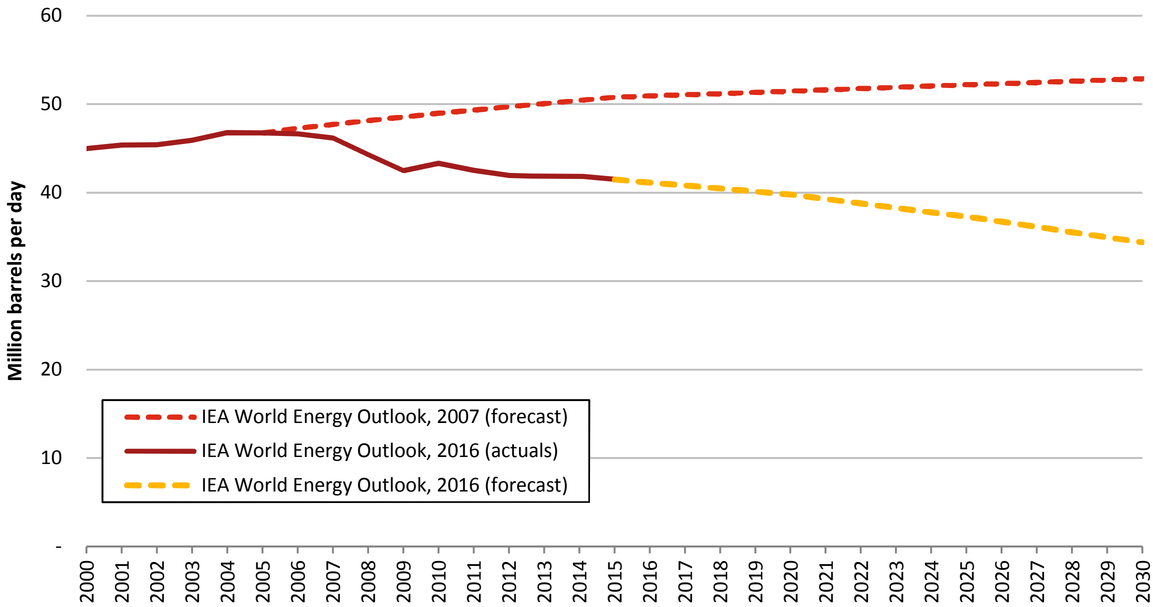
From 1999 to 2007, demand growth began to slow. Western economies became gradually less energy-intensive, meaning that demand for hydrocarbons increased at around a sixth of GDP growth. This was due to a range of efficiency factors, most notably increases in vehicle fuel efficiency. Many Western governments encouraged the uptake of more fuel efficient vehicles via the tax and licensing systems, and manufacturers responded by developing more efficient vehicles. This period saw high rates of 'dieselisation' in some markets as consumers were encouraged to move to more fuel-efficient diesel engines. However, during this period the full gains of efficiency were not realised as cars became, on average, much heavier. In some markets such as the US (where SUV uptake has been strongest) actual car fuel efficiency fell during the 2000s, despite significant gains in engine efficiency.

Since 2007, hydrocarbon demand has been in decline in developed markets even though GDP has been growing. While the decline was accentuated by the global financial crisis of 2008, the decline has turned out to be structural, not cyclical, as demand has continued to fall even as western economies have returned to growth. The structural decline reflects factors including:

- Significant additional gains in engine efficiency (supported by increasing fiscal incentives and high oil prices)
- Scrappage rates increasing with economic growth and government scrappage schemes, taking older, less efficient vehicles off the road
- Parallel improvements in domestic energy efficiency, for example in more efficient boilers, greater home insulation and more efficient lighting technologies
- Greater consumer awareness of environmental issues leading to more careful use of energy, also supported by high energy costs
- The continuing elimination of HFO as a source of fuel in the power and industrial sectors
- The emergence of hybrid vehicles and EVs

Back in 2007, this decline was not commonly forecast. The 2007 forecast from the International Energy Agency (IEA) expected continuing growth of 0.8% p.a. in hydrocarbon demand in developed economies 2007-2015. In reality, demand declined at 1.3% p.a. Total demand for hydrocarbons in developed economies was 10% lower in 2016 than in 2007 and 18% lower than was forecast. While part of this discrepancy was due to the unforeseen global financial crisis, the IEA's latest forecast, from 2016, now predicts a continuing decline in hydrocarbon demand in developed economies driven by a continuation of many of the above factors.

**Figure 2.3: IEA OECD oil demand forecasts, 2007 and 2016**




*Source: IEA World Energy Outlook*

| | CAGR | | |
|---|---|---|---|
| | **2000-2006** | **2007-2015** | **2016-2030** |
| **IEA World Energy Outlook, 2007** | 0.6% p.a. | 0.8% p.a. | 0.3% p.a. |
| **IEA World Energy Outlook, 2016** | 0.6% p.a. | -1.3% p.a. | -1.3% p.a. |

Actuals    Forecast

A continuing decline is also forecast by other reputable sources including BP and Wood Mackenzie who both forecast demand to fall by around 11-12% in Europe from 2015-2030. These forecasts are all based on energy efficiency and substitution continuing to outweigh the expected rates of economic growth.

Since 2007, the concept of "peak supply", where oil production was believed to be insufficient to meet demand, has therefore been replaced by the concept of "peak demand", where oil consumption is forecast to continue falling in developed markets.

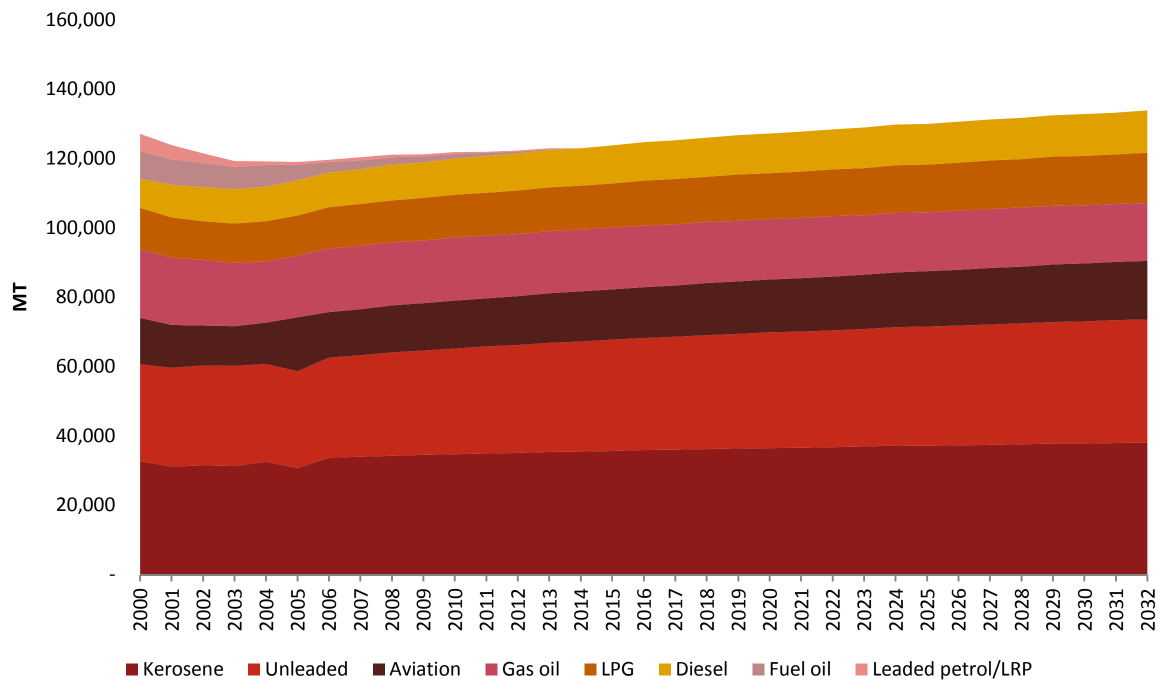
## 2.2.2 Previous hydrocarbon forecasts in the Channel Islands

We have identified two previous studies that forecasted hydrocarbon demand in the Channel Islands.

- Economic feasibility of supplying hydrocarbon fuels to Jersey by pipeline – draft report, 2007
- Guernsey Future Harbour Requirements Study, 2010

The forecast for Jersey was conducted in 2007, when the global industry consensus was that demand in developed economies would continue to grow. Using regression relationships from historical data and long-term historical trends, the report anticipated a modest increase in hydrocarbon demand over the following 25 years, but it did acknowledge that increases in fuel efficiency and carbon costs could drive a decrease in demand.

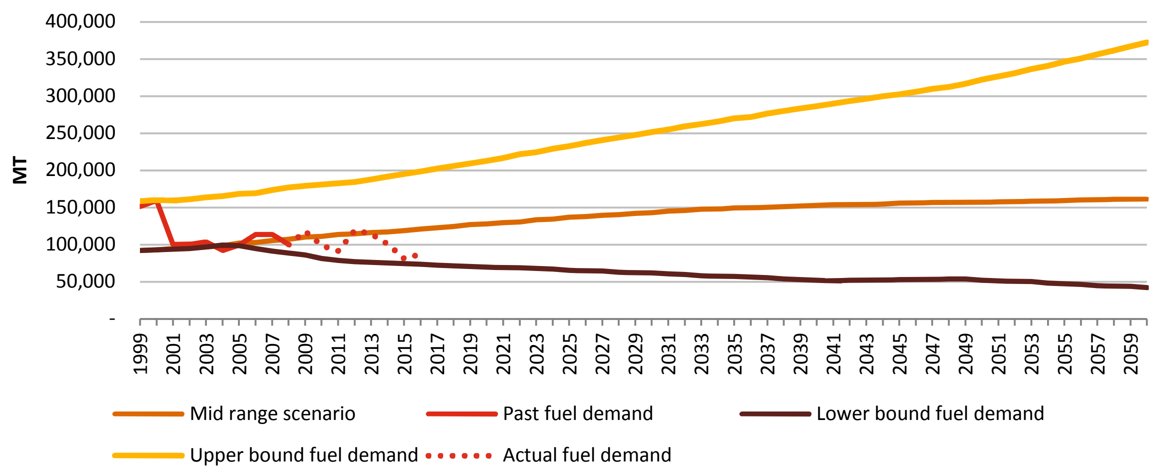
**Figure 2.4: Annual consumption of hydrocarbon products in Jersey, 2000-2032 ("Economic feasibility of supplying hydrocarbon fuels to Jersey by pipeline", 2007)**




*Source: "Economic feasibility of supplying hydrocarbon fuels to Jersey by pipeline", 2007*

The Guernsey Future Harbour Requirements Study projected a mid-range scenario showing an increase of 0.7% p.a. to 2060. This forecast is based on an extrapolation of historical demand from 2001 to 2008, which showed growth in line with global trends. The structural decline in global demand had not yet become clear (2008 showed a cyclical decline as a result of the global financial crisis). The report also showed a 'lower bound' case, reflecting a -1.3% p.a. decline to 2060. Actual data from 2009 to 2016 shows that hydrocarbon demand on Guernsey has broadly tracked between the mid-range and lower bound scenarios.

**Figure 2.5: Combined demand for fuel, 1999-2059 ("Guernsey Future Harbour Requirements Study", 2010)**




*Source: "Guernsey Future Harbour Requirements Study" (2010)*

## 2.2.3 Implications and our methodology

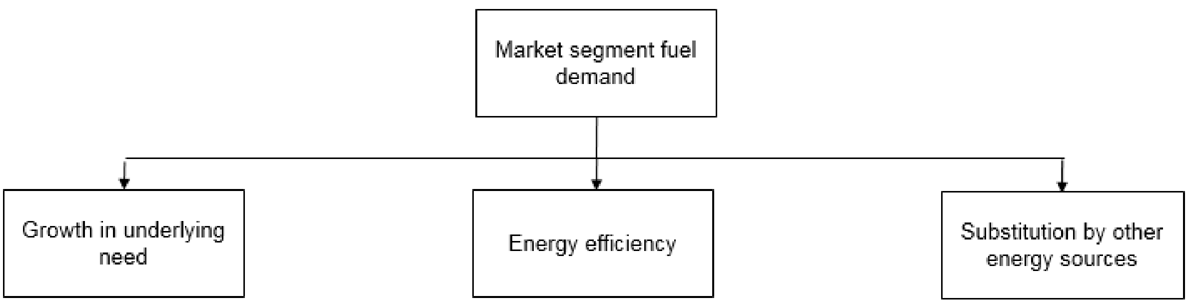
As discussed above, the global hydrocarbon market has undergone significant change over the last decade, with industry consensus moving from 'peak supply' to 'peak demand' since the last study was concluded. This has made forecasting difficult (globally, as well as on the island specifically).

Forecasting on the island is also constrained by the availability of historical data, which is only available on a consistent basis back to 2008; being a smaller market, historical demand has been volatile, making it more difficult to see the underlying trends.

Both these factors mean that forecasting by extrapolating of historical trends is difficult. For this reason we have sought to understand the underlying drivers of each hydrocarbon market and build a 'bottom-up' model of demand based on forecast changes to these drivers. We have divided hydrocarbon demand into five market segments: Road Transport, Heating, Electricity, Aviation and Marine.

For each market segment we have sought to understand historical and forecast changes in the three underlying drivers of hydrocarbon demand: growth in underlying need, energy efficiency and substitution by other energy sources.

**Figure 2.6: Hydrocarbon demand drivers**



Growth in underlying need represents demand on the island for the service that the energy provides – for example transport or heating. Much of this is driven by macroeconomic drivers such as population growth or GDP.

The next section of this report therefore looks at these economic drivers which are common to each market segment. These economic forecasts are then used in each of the following sections to support the demand forecast in each market segment.

# 2.3 Macroeconomic assumptions

## 2.3.1 Population

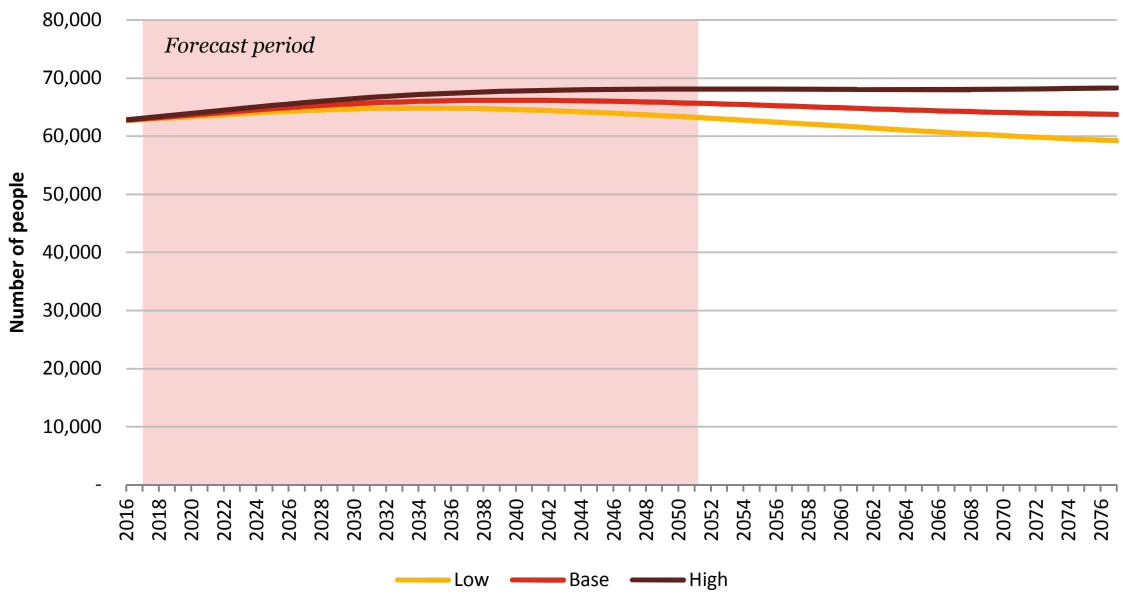
We have received population forecasts for Guernsey from the States of Guernsey Policy & Resources Committee. The projections were developed by the UK Government Actuary's Department. The forecast is calculated using estimated birth rates and death rates with three scenarios using net inward migration of +100 (low), +150 (central) and +200 (high).

The forecast is relatively flat, with the central migration scenario showing slow growth to reach a peak population of around 66,000 in 2039 before declining at 0.1% p.a. to 2077 (the last year of the forecast).

The low migration case peaks at around 65,000 while the high case carries on growing marginally to 2077.

The population declines in the outer years due to migration being insufficient to outweigh the difference between birth and death rates.

**Figure 2.7: Population projections, 2016-2077**




*Source: Guernsey Policy & Resources Committee*

| | Population | | |
|---|---|---|---|
| | **2015** | **2050** | **CAGR** |
| **Base** | 62,571 | 65,767 | 0.14% p.a. |
| **High** | 62,571 | 68,104 | 0.24% p.a. |
| **Low** | 62,571 | 63,426 | 0.04% p.a. |

We have used the three migration scenarios as our base, high and low scenarios for population growth in our hydrocarbon demand forecast.

| | Base | High | Low |
|---|---|---|---|
| **Population** | Policy & Resources population projection with +150 migration | Policy & Resources population projection with +200 migration | Policy & Resources population projection with +100 migration |

We note that there is a discrepancy between the population forecasted for 2016 and the actual population recorded in Guernsey's Facts and Figures booklet. We have therefore used the percentage change in the population forecast to project future populations from the population in 2016.

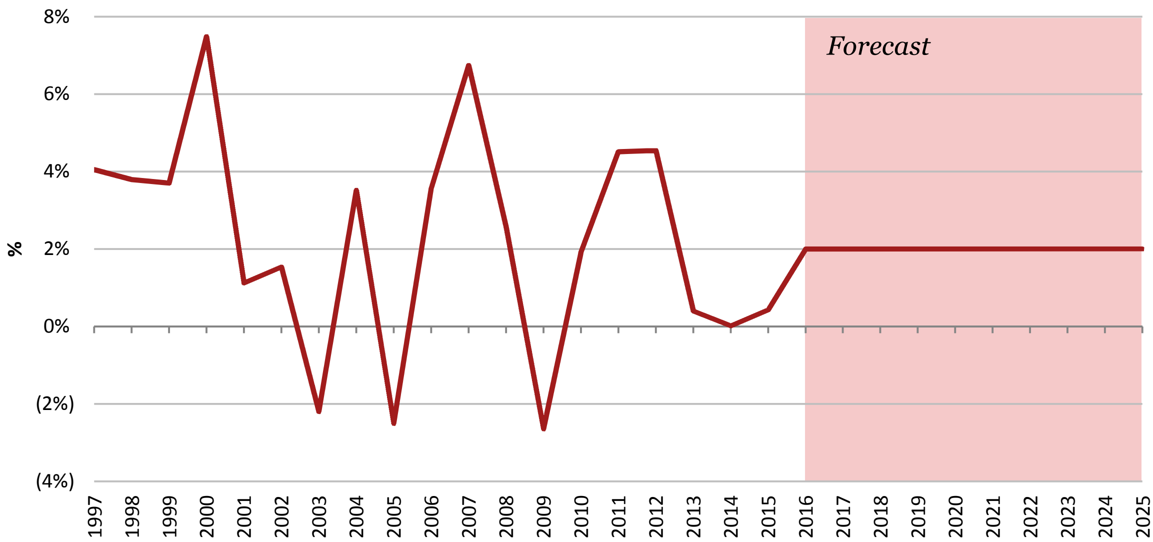
## 2.3.2Gross Domestic Product (GDP)

GDP in Guernsey in 2015 was £2.4bn. Around 48% of the economy is made up of finance and business services.

Looking historically, GDP growth has been relatively volatile since 1996, with a high of 8% in 2000 and a low of -3% in 2009 following the financial crisis.

Nevertheless, GDP has shown a generally positive trend. For example, in the past nineteen years Guernsey has experienced only three years of negative growth.

**Figure 2.8: Guernsey GDP growth, 1997-2025**




*Source: Guernsey Policy & Resources Committee*

| | CAGR |
|---|---|
| **1996-2015** | 2.2% p.a. |

According to the States of Guernsey Policy & Resources Committee, 2.0% p.a. real GDP growth is assumed in economic forecasts. This is very similar to the historic CAGR of 2.2% p.a. This means that GDP is forecast to be £4.7bn by 2050, representing a doubling of Guernsey's current real GDP.

The States of Guernsey Policy & Resources Committee have stated that they do not forecast a significant change in the composition of GDP over the forecast period, i.e. financial services will continue to be the dominant industry on the island.

## 2.4 Scenario overview

In order to reflect the range of variables and uncertainties inherent in forecasting over such a long period, we have used scenarios and discrete event 'toggles' to reflect a range of possible outcomes.

We have developed three scenarios for forecast demand. These represent alternative but realistic scenarios based on current information and existing States of Guernsey policy.

- The 'base case' scenario represents our view of the median outcome, i.e. the forecast where we believe the eventual outcome is equally likely to be greater or less than the forecast.
- The 'low case' scenario shows how the forecast would be different with an alternative, but still realistic, set of assumptions, that together drive a lower level of demand. It is not intended to represent a 'minimum' demand case.
- The 'high case' scenario shows how the forecast would be different with an alternative, but still realistic, set of assumptions, that together drive a higher level of demand. It is not intended to represent a 'maximum' demand case.

The scenarios draw upon a number of assumptions and third party research which will be presented in the relevant sections. Sources that are used in more than one section include:

- Analysis by National Grid in the UK of alternative energy demand scenarios. National Grid provides four scenarios based on different levels of economic growth and environmental concern. As part of this analysis it provides different assumptions for the following variables which we use in our report:
  - Heating demand per capita;
  - Residential lights and appliances demand per capita;
  - Commercial electricity demand per capita;
  - Electricity demand per EV;
  - Uptake of heating technologies.
- Forecasts by Wood Mackenzie, a global energy industry consultancy, of the rate of uptake of EVs and of the rate of increase in vehicle efficiency.

The table below shows which assumptions we have used for each of the base, high and low scenarios.

| Segment | Demand driver | Base | High | Low | Source & date |
|---|---|---|---|---|---|
| All market segments | Population | +150 net migration per year | +200 net migration per year | +100 net migration per year | States of Guernsey, January 2017 |
| Road transport | Fuel efficiency | Decline of -0.7% p.a. | Decline of -0.7% p.a. | Decline of -0.7% p.a. | DfT, January 2017<br><br>Wood Mackenzie, January 2017 |
| | Uptake of EVs | Uptake of EVs in Guernsey is similar to the uptake of EVs in the UK | Uptake of EVs in Guernsey is similar to 50% of the uptake of EVs in the UK | Uptake of EVs in Guernsey is similar to the uptake of EVs in Norway to 2037 and then uses the GEL forecast | Wood Mackenzie, January 2017<br><br>GEL, December 2016 |
| Heating | Market share | Heating source mix stays constant | Heating source mix stays constant | Electricity market share doubles to 56% by 2050 | Stakeholder interviews in Guernsey, December 2016 |

| | | | | | |
|---|---|---|---|---|---|
| Heating | Efficiency | Average of all four National Grid scenarios | Low economic growth and little focus on environmental issues ("No Progression") | High economic growth and high focus on environmental issues ("Gone Green") | National Grid Future Energy Scenarios, 2016 |
| Electricity | Efficiency | Average of all four National Grid scenarios | "No Progression" scenario | "Gone Green" scenario | National Grid Future Energy Scenarios, 2016 |
| Aviation | Aircraft movements | Remains constant at 2015 levels | 15% growth to 2025, then remains constant | 17% decrease to 2025, then remains constant | Civil Aviation Authority, Guernsey Airport business plan |
| | Fuel efficiency | No improvement in efficiency until 2026, then follows the central demand scenario in UK aviation forecasts | Follows the UK central demand scenario in UK aviation forecasts | Follows the UK high demand scenario in UK aviation forecasts | UK Aviation forecasts, 2013 |
| Marine | Fuel demand growth | 0.0% growth p.a. | 30% growth over 10 years, then at the Policy and Resources population projection with +200 net migration a year | -0.5% growth p.a. | Guernsey Tourism Strategic Plan 2015-2025, 2015 |

In addition, there are a number of discrete events that have the potential to impact hydrocarbon demand but that are not easily forecastable. In order to illustrate their potential impact we have created a set of 'toggles' that can be overlaid on the forecasts to show what might happen if these discrete events occurred. These include:

- A particularly cold winter, which would increase demand for heating fuel
- The construction of a second electricity interconnector on to the island
- The temporary failure of an interconnector, for an illustrative period of 9 months

# 3. Hydrocarbon demand forecast

# 3.1 Road transport fuel demand

## 3.1.1 Executive Summary

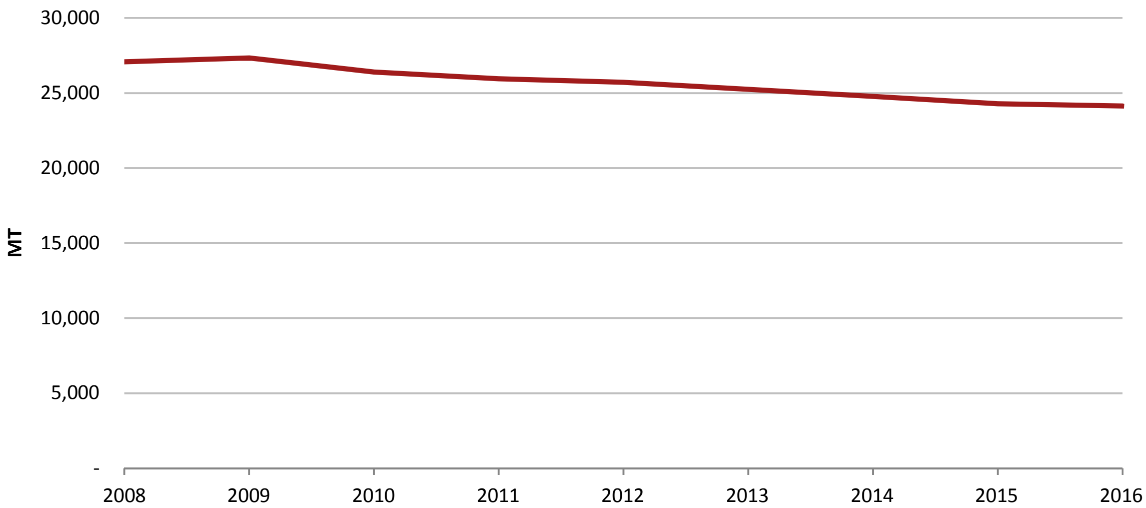
- We have defined road transport fuel demand as the combined total volume of petrol and diesel that are consumed to supply Guernsey's road transportation requirements;
- Road transport fuel demand has dropped since 2008 by -1.4 % p.a., likely due to pump price increases and fuel efficiency improvements;
- Road transport fuel demand is driven by economic growth, efficiency and the uptake of alternative technologies such as electric vehicles (EVs);
- We have assumed that vehicle fuel efficiency will continue to improve in line with recent historical improvements in UK fuel efficiency;
- We have not assumed any modal shift away from road transport to walking or cycling, nor any significant impact from greater vehicle sharing;
- The biggest uncertainty is the uptake of EVs. Our base case uses an industry forecast for uptake in the UK, our low case uses the uptake in a more environmentally focussed market as well as forecasts from GEL, and our high case assumes half the uptake of the UK.
- Our base case forecasts road transport fuel demand to drop by -1.1% p.a. from 24,133MT in 2016 to around 16,800MT in 2050;
- Our low case indicates a drop of around -4.2% p.a. due to a higher uptake of EVs, whereas our high case suggests a decline of around -0.7% p.a.;

## 3.1.2 Historical demand trends

We have defined road transport fuel demand as the combined total volume of petrol and diesel in metric tonnes that are consumed to supply Guernsey's road transportation requirements. This includes all forms of road transport, including private, public and commercial vehicles.

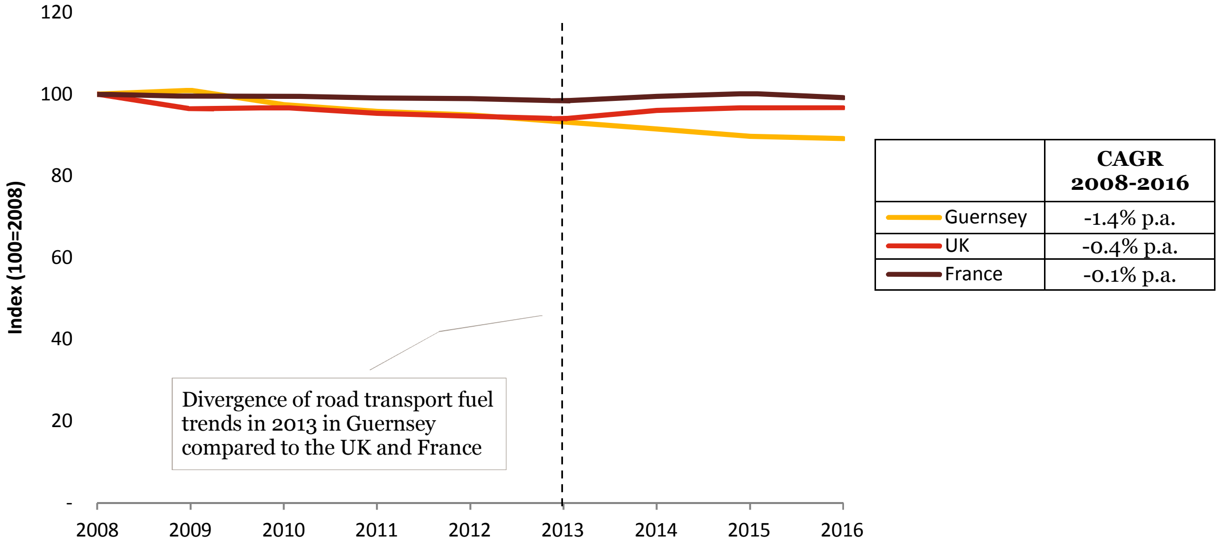
On Guernsey, demand for road transport fuel has steadily fallen from 27,078 MT in 2008 to 24,133 MT in 2016, representing a CAGR of -1.4% p.a.

**Figure 3.1 Road transport fuel demand, 2008-2016**




*Source: Guernsey Customs & Excise*

### Figure 3.2: Fuel demand of UK, France and Guernsey, index to 2008

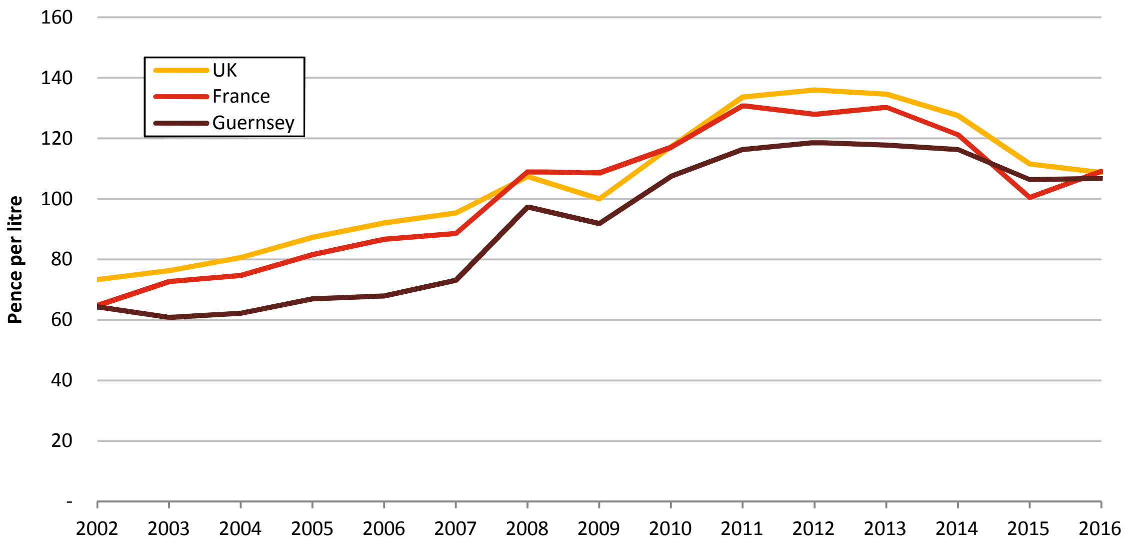



*Source: Customs & Excise, Wood Mackenzie*

Road transport fuel demand in Guernsey trended closely with the UK from 2008 to 2013 (with the exception of 2009 where the recession affected the UK worse than Guernsey). In the UK, this decline in road transport fuel demand has been due to improving fuel efficiency combined with rising fuel prices.

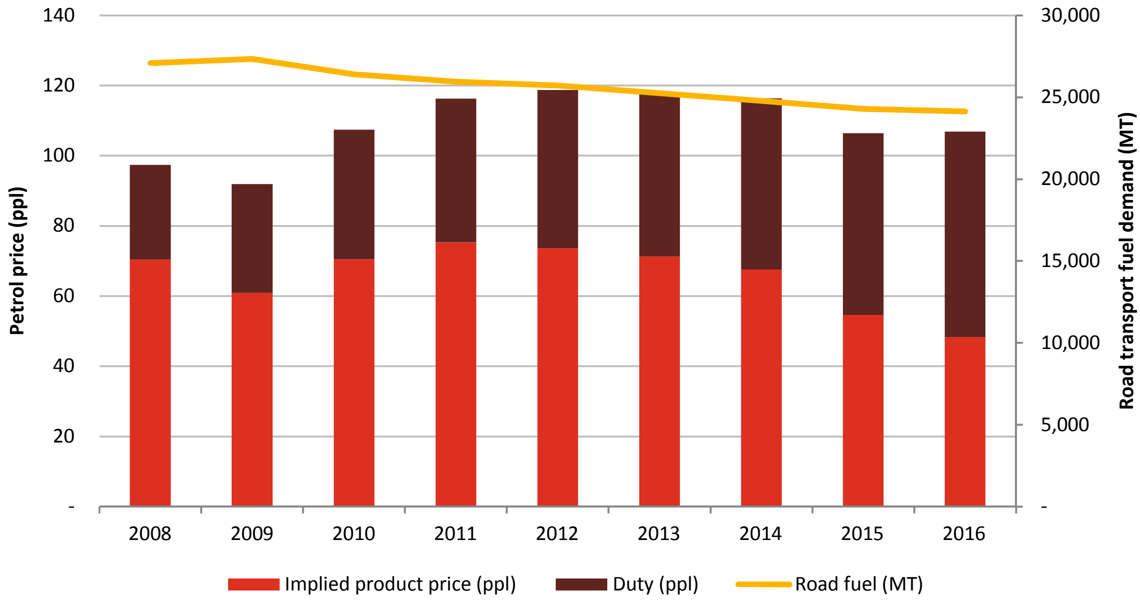
Since 2013 Guernsey has seen a continuing decline in demand, in contrast to the UK and France which saw a partial rebound in demand. This divergence may be due in part to different fuel pricing trends. The UK and France saw sharp reductions in average pump prices from 2013 to 2015 of -17% and -23% respectively as the lower oil price fed through to retail prices. In contrast, average pump prices in Guernsey only fell by -10% due to increases in fuel duties.

### Figure 3.3: Average petrol pump prices in the UK, France and Guernsey, 2002-16




*Source: Guernsey Policy & Resources Committee, Wood Mackenzie*

**Figure 3.4: Composition of petrol pump price and road transport fuel demand in Guernsey, 2008-2016**




*Source: Guernsey Policy & Resources Committee, Guernsey Budget*

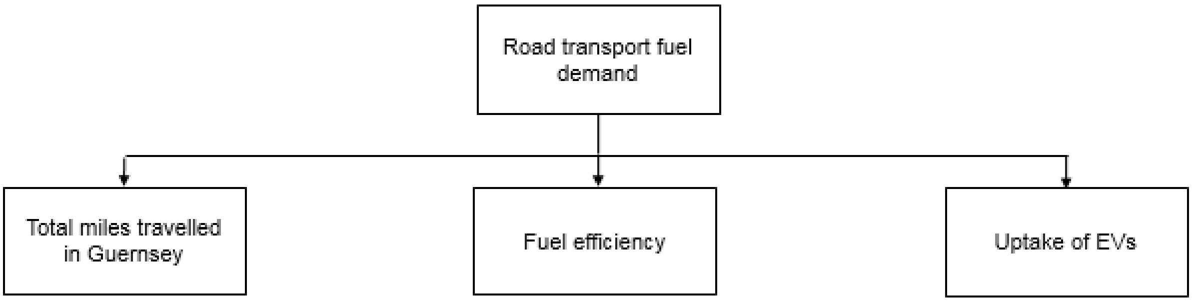
While comparisons with the UK and France are instructive, there are a number of key differences between road transport in these markets and in Guernsey which may cause different fuel demand dynamics:

- Guernsey's smaller size and slower average speeds mean that drivers travel shorter distances per year. A 2007 paper suggested that on average a car on Guernsey covers 6,000 miles every year, compared to 9,500 in the UK;
- There is a higher rate of vehicle ownership in Guernsey than the UK. In 2015, there were 82,777 registered vehicles in Guernsey, which includes vehicles in and out of use. If we assume there are 55,000 vehicles in use (using the latest taxed for use data from 2007), there are 0.88 vehicles per person, compared to 0.56 vehicles per person in the UK;
- Guernsey does not have MOTs, which may mean there are older, less efficient vehicles on the road. We do not have data on the average age of vehicles in use on the island;
- Although there are currently only 113 EVs in Guernsey, the island's small size and lack of high speed roads may make it an attractive location to drive such vehicles.

## 3.1.3 Forecast methodology and assumptions

We apply the three fundamental drivers of hydrocarbon demand to the road transport segment as shown below.

**Figure 3.5: Road transport fuel demand drivers**




The underlying use demand is the total distance travelled by road vehicles on the island. Fuel efficiency is the increasing efficiency of fuel vehicles and the primary substitution technology is the proportion of EVs in the vehicle fleet.

Note that electricity demand for EVs will be dealt with in the 'Electricity' section 2.3 of the report.

## *Total miles travelled*

Total miles travelled can be assessed in terms of population and average distance travelled by person in a motor vehicle.

The population forecasts were presented and discussed in the Macroeconomic Assumptions section of this report and showed gradual growth to 2039.

Reliable historical data on average miles travelled per person is not available in Guernsey. In the UK, the average vehicle travelled around 8,700 miles in 2014. For our base case, we have assumed that average distance travelled by person in a motor vehicle on Guernsey remains constant over the forecast period, for the following reasons:

- The island is small and self-contained, leading to fewer opportunities for longer, discretionary journeys; average journey distance is therefore unlikely to change
- The island has a much higher number of vehicles per person than the UK, implying that almost everyone who wants to use a vehicle has access to a vehicle; increases to the vehicle fleet would not therefore lead necessarily to an increase in vehicle use
- We have assumed that there is no significant move towards public transport, cycling or car sharing over the forecast period. A significant change in consumer behaviour, driven for example by high fuel prices, government policy or new public transport infrastructure could decrease future demand

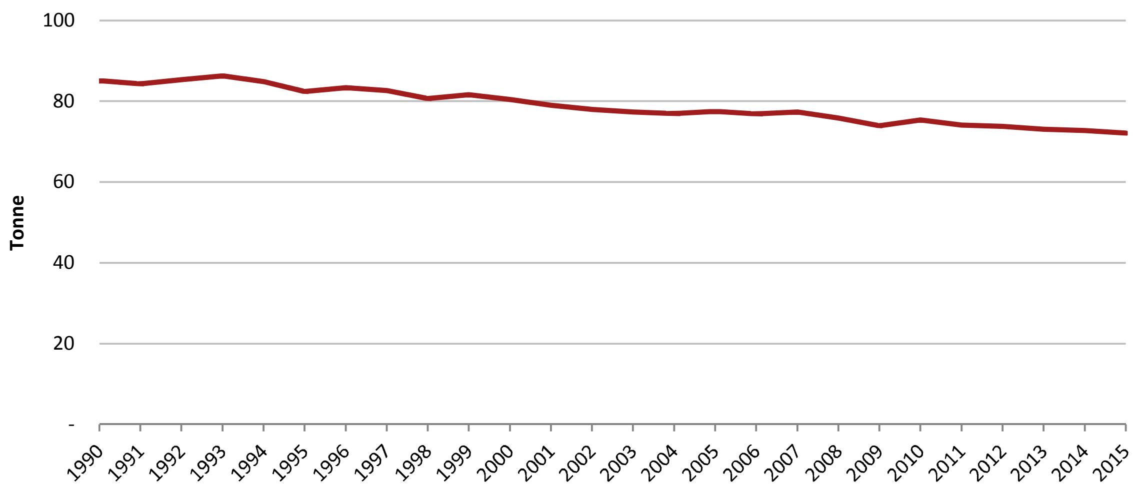
## *Fuel efficiency*

The change in the average fuel efficiency of a vehicle fleet is determined by four factors: average fuel efficiency of the current fleet, new build fuel efficiency, scrapping rates and new build rates. The average fleet fuel efficiency will decline if older less efficient vehicles are scrapped (measured by the scrapping rate) and/or newer more efficient vehicles enter the fleet (measured by the new build rate). Therefore, the average fuel efficiency of the vehicle fleet will typically be higher than the new build efficiency.

As discussed in the section on global hydrocarbon demand, improvements in average vehicle efficiency have been a major factor over the past decade. For example, one way to analyse vehicle efficiency is to measure carbon dioxide emissions. According to the Society of Motor Manufacturers and Traders (SMMT) in the UK, the average new car in 2015 emitted 121 g/km of carbon dioxide. This compares to 165 g/km in 2007, a drop of 26%, equating to 3.8 % p.a. This means that on average a new car is some 30% more efficient than a car leaving the fleet at the end of its useful life (which is on average 12 years old in the UK) and 20% more efficient than the average car currently in use.

A second method of analysing fuel efficiency is to look at the number of miles a vehicle travels for each unit of fuel consumed. The average number of litres of fuel consumed per mile travelled in the UK has decreased from 76.8 MT/million vehicle-miles in 2006 to 72.1 MT/million vehicle-miles today. This represents an efficiency gain of 0.7% p.a., meaning that every year, the UK fleet as a whole gets 0.7% more efficient as older vehicles leave the fleet and new vehicles replace them.

**Figure 3.6: Tonnes per million vehicle-km, 1990-2015**




*Source: UK Department for Transport, Wood Mackenzie*

In the absence of the same data for Guernsey, we assume that Guernsey is seeing the same trend as the UK. This assumes that:

- The active vehicle fleet in Guernsey is being renewed at approximately the same rate as that of the UK. While we have anecdotal evidence that cars might be kept for longer on Guernsey, we assume that older cars are less likely to be in regular use than new cars (given that there are more cars than people)
- Vehicle efficiency gains are the same irrespective of different driving patterns on Guernsey. We assume that the shorter average journey and the lower annual mileage do not imply that changes in efficiency changes at a different rate to in the UK.

## *Uptake of EVs*

EVs represent a possible step-change in the demand for road transport hydrocarbons. While they currently account for a very small proportion of the vehicle fleet (around 0.2% in both the UK and Guernsey), uptake in developed markets is expected to be material over the forecast period. Unlike hybrid vehicles, most of which still burn hydrocarbons as the primary fuel, full EVs do not have an internal combustion engine and rely solely on charging from an electricity supply. In this section we consider the impact on road fuel demand; the additional demand for electricity is covered in section 2.3.

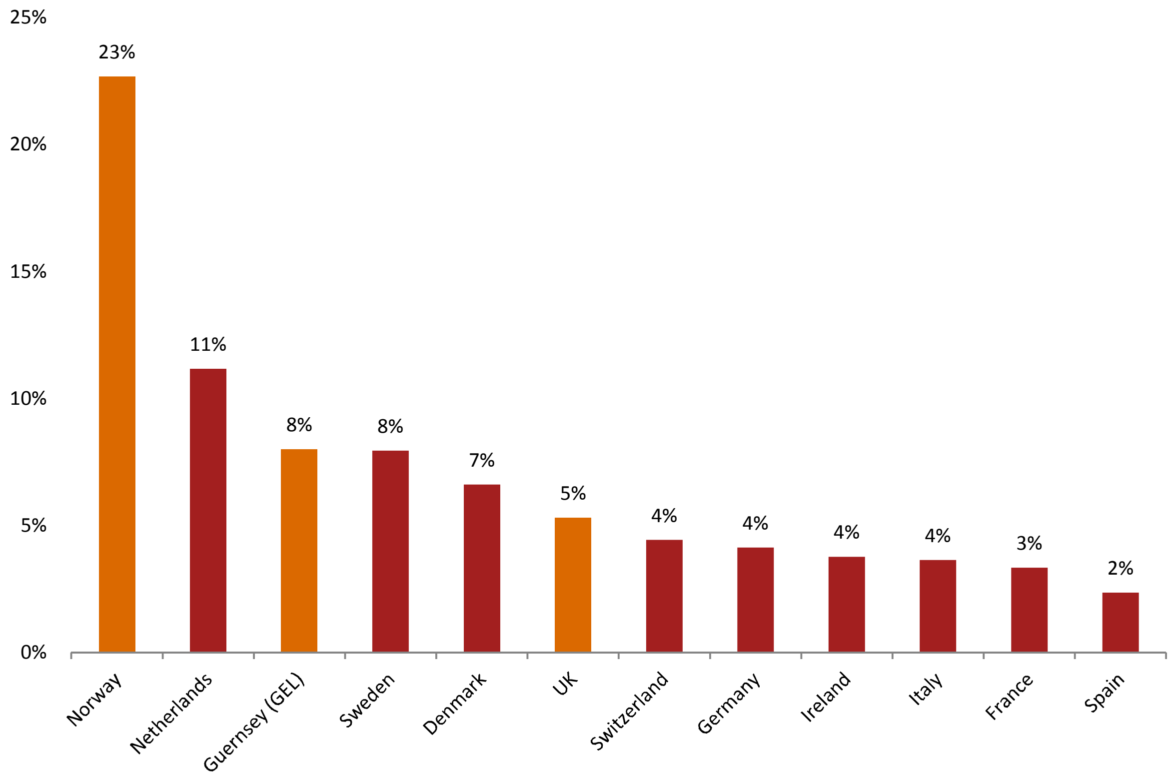
The rate of uptake of EVs is uncertain. As with other developed markets, the rate of uptake in Guernsey will depend on factors including:

- The price of EVs compared to conventional equivalents
- Advances in range, charging speed and performance of EVs

- Consumer appetite for 'green' products in general, and acceptance of EVs in particular
- Suitability of EVs for local traffic, terrain and driving patterns
- Government subsidies and policies to encourage uptake (noting that at the moment there are no such policies in place in Guernsey)

Independent forecasts are available for the uptake of EVs in major markets. In addition, GEL has produced its own forecasts for uptake in Guernsey. The below chart compares forecast from Wood Mackenzie for uptake of EVs by 2030 in selected markets and the GEL forecast.

**Figure 3.7: EVs as a percentage of the total car fleet in 2030 by selected markets**




*Source: Wood Mackenzie*

In order to generate our scenarios, we have used a combination of the Wood Mackenzie forecasts for UK and Norway and the GEL forecast for Guernsey.

Wood Mackenzie forecasts that EVs will comprise around 5% of the UK's car fleet by 2030. We have used this UK benchmark as our base case scenario for the following reasons:

- The current penetration of EVs is similar in the UK and in Guernsey (around 0.2%)
- The UK is expected to be largely driven by market forces, not by government policy. Although there have been some government initiatives (such as exemption from road tax), they have to date been small-scale compared to the typical purchase price.
- Guernsey has a higher degree of cultural and social linkages to the UK than to other major markets, implying that consumer appetite and awareness of EVs is likely to be more similar to the UK than other markets.

The highest forecast penetration in a major market is Norway, where EVs are expected to represent 23% of the fleet by 2030. Cars are the primary method of transportation in Norway (as on Guernsey), with around 90% of all motorised passenger-kilometres in Norway being completed in cars. Around 4% of the Norwegian car fleet is already electric, which is the highest in Europe.

Norway has one of the most ambitious plans in Europe for the uptake of EVs, including extensive fiscal and non-fiscal incentives. For example:

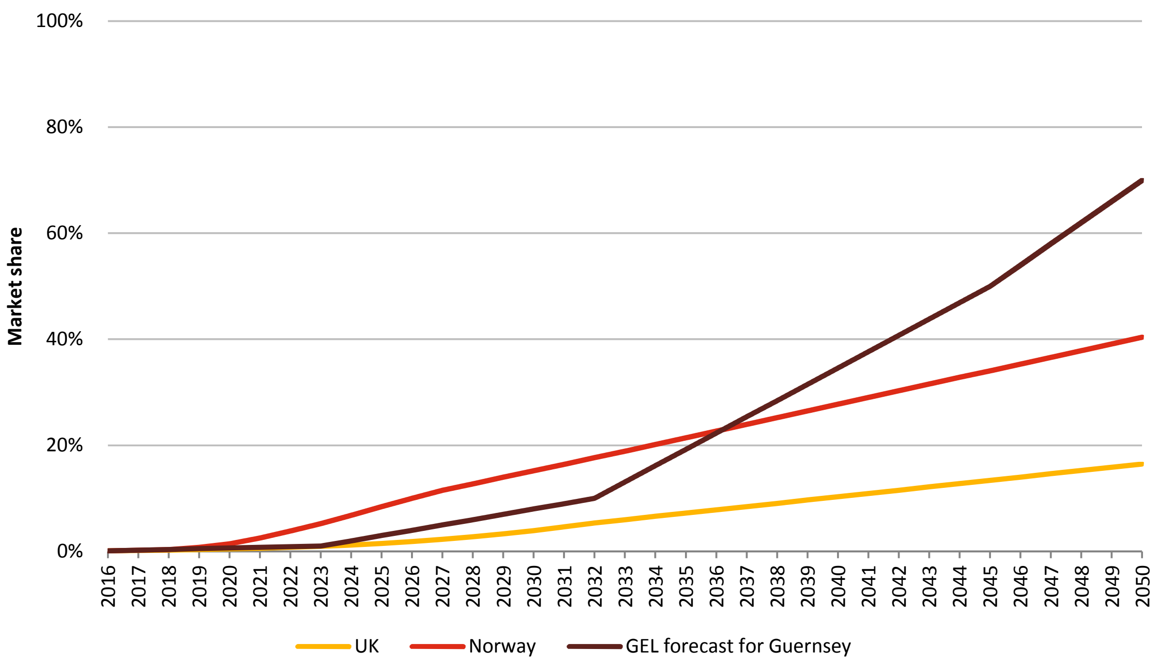
- Norway has set itself a target of 85 g/km of CO2 emission by 2020, as opposed to 95 g/km in the EU;
- EVs have an exemption from VAT, which normally adds 25% of a vehicle's list price to the purchase price;
- Battery EVs are exempted from registration tax;
- Battery EVs have preferential access to large parts of public infrastructure;
- There is strong political pressure within the Norwegian government for all new cars to be zero emission by 2025.

We have used the Norwegian forecast uptake of EVs as our low fuel scenario to 2036 as it shows the upper limit for penetration based on current industry expectations for developed markets. Note that this uptake is in part driven by government policies that are not currently replicated on Guernsey.

After 2036 we use the forecasts from GEL, which expects an even faster rate of uptake in the outer years. There is an argument that local driving patterns on Guernsey make EVs more attractive than in the UK. Furthermore, in a small community it is possible that uptake will initially be slower, but will accelerate faster once EVs are culturally acceptable. Both of these factors are reflected in GEL's forecast, which expects a slow uptake until around 2030, followed by rapid growth in uptake to reach 70% by 2050.

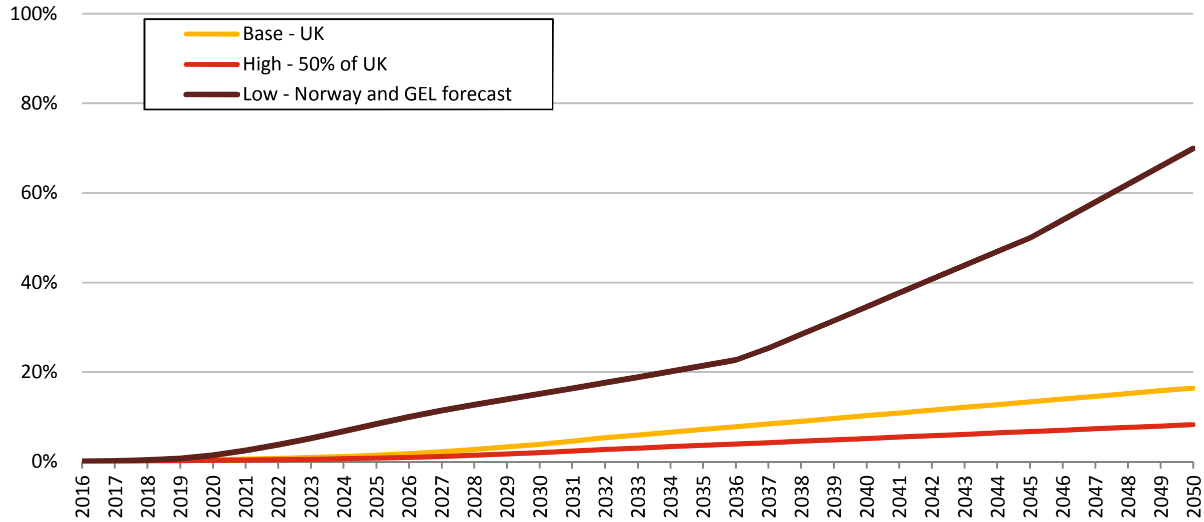
For our high fuel scenario, we have used half the rate of uptake forecast for the UK. This is an illustrative scenario that reflects a more pessimistic view of Guernsey's consumer appetite for EVs. This scenario implies that EVs are not considered less appropriate or attractive in the Guernsey market than in other developed markets. This may be supported by Guernsey residents' higher average wealth making them more willing to pay for road transport fuel.

**Figure 3.8: Industry forecasts for the uptake of EVs, 2016-2050**



*Source: Wood Mackenzie, GEL*

**Figure 3.9: Forecasted proportion of EVs in Guernsey, 2016-2050**



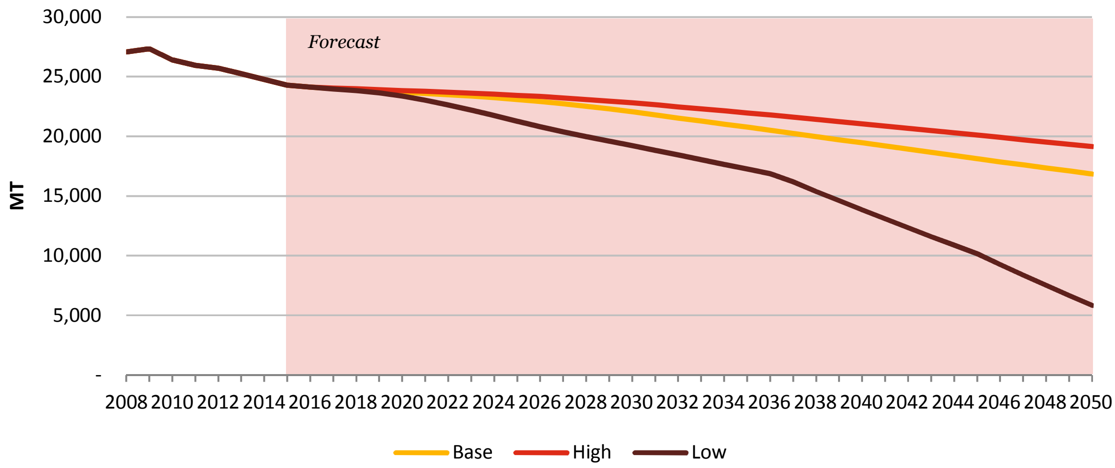

Our forecast for fuel efficiency and uptake of EVs in our base and high case from 2031 to 2050 is based on the average forecasted changes of 2026-2030.

Guernsey Gas has suggested that there may be an increased uptake in LPG-powered vehicles in Guernsey. However, there are currently only 30 LPG vehicles in Guernsey, all of which were previously owned by Guernsey Gas. There is also only one LPG filling station and there is no evidence of people importing autogas vehicles into Guernsey or converting vehicles to become LPG-powered. Wood Mackenzie does not view autogas vehicles as being a growth area. We have not therefore considered the uptake of LPG vehicles in our forecast.

## 3.1.4 Conclusions

We forecast that total demand for road transport fuel will continue falling over the period. In our base case demand falls by -1.1% p.a. from 24,133 MT in 2016 to around 16,800 MT in 2050.

**Figure 3.10: Road transport fuel demand forecast, by scenario, 2008-2050**




| | CAGR | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **Base** | -1.4% p.a. | -1.1% p.a. |
| **High** | -1.4% p.a. | -0.7% p.a. |
| **Low** | -1.4% p.a. | -4.2% p.a. |

The base case forecast reflects the following underlying assumptions:

- The population increases as expected by the States of Guernsey
- There is no shift away from road transport to other modes of transport
- The fuel efficiency of vehicles continues to increase at the same rate as seen in the UK historically
- The uptake of EVs mirrors that currently expected in the UK.

The high and low scenarios are based on different assumptions, as explained above and summarised in the table below.

| | Population | Fuel efficiency | EV fleet forecast |
|---|---|---|---|
| **Base** | Policy & Resources population projection with +150 migration | Improvement of -0.7% p.a. | Uptake of EVs in Guernsey is similar to the uptake of EVs in the UK |
| **High** | Policy & Resources population projection with +200 migration | Improvement of -0.7% p.a. | Uptake of EVs in Guernsey is similar to 50% of the uptake of EVs in the UK |
| **Low** | Policy & Resources population projection with +100 migration | Improvement of -0.7% p.a. | Uptake of EVs in Guernsey is similar to the uptake of EVs in Norway to 2037 and then uses the GEL forecast |

# 3.2 Heating demand

## 3.2.1 Executive Summary

- We have defined heating demand as the energy needed to meet residential and commercial space heating, water heating and cooking requirements. In Guernsey, there are four primary sources of heating energy: heating oil, gas oil, electricity and LPG;
- Heating energy demand is primarily driven by heating efficiency gains and average winter temperatures;
- Historical data for heating oil and LPG show a downward trend in heating demand of around -0.7% p.a. for heating oil and -5.7% p.a. for LPG. There was a spike in demand in 2010 due to a cold winter;
- We have used UK National Grid forecasts to project heating efficiency per person and used stakeholder interviews in Guernsey to guide our forecast of market shares between the four heating energy sources;
- Our base case shows a drop in hydrocarbon demand for heating by -0.7% p.a. This is led by -0.9% p.a. heating efficiency gains;
- Our low case includes a more rapid improvement in heating efficiency and take up of electricity than our base case, leading to a -1.7% p.a. decline in hydrocarbon demand over the forecast period. Our high case shows flat hydrocarbon demand based on limited efficiency gains, no change in heating source mix and a higher population projection.
- We have shown the impact of a cold winter, based on 2010, which creates a 10% increase in heating demand.

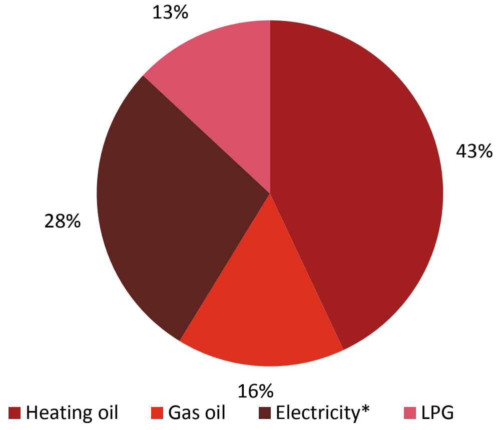
## 3.2.2 Historical demand trends

### *Market share*

We define heating demand as the energy needed to meet space heating, water heating and cooking requirements in residential and commercial properties.

In Guernsey, this is a highly complex market where the usage of heating sources is very different to the UK. For example, in Guernsey heating oil and gas oil make up more than half the heating market, whereas gas made up around 75% of the UK heating market in 2016.

**Figure 3.11: Guernsey heating energy market shares, 2016**




| *(2016)* | **GWh** | **Tonnes** |
|---|---|---|
| **Heating oil** | 274 | 21,331 |
| **Gas oil** | 100 | 7,971 |
| **Electricity*** | 93 | N/A |
| **LPG** | 83 | 6,075 |
| **Total** | **550** | **35,377** |

*Source: PwC analysis*

*Electricity demand for heating has been estimated using discussions with GEL. This assumes no HFO imports are required to meet electricity demand at this stage of the report. HFO imports are discussed in the 'Electricity' 2.3 section of this report.

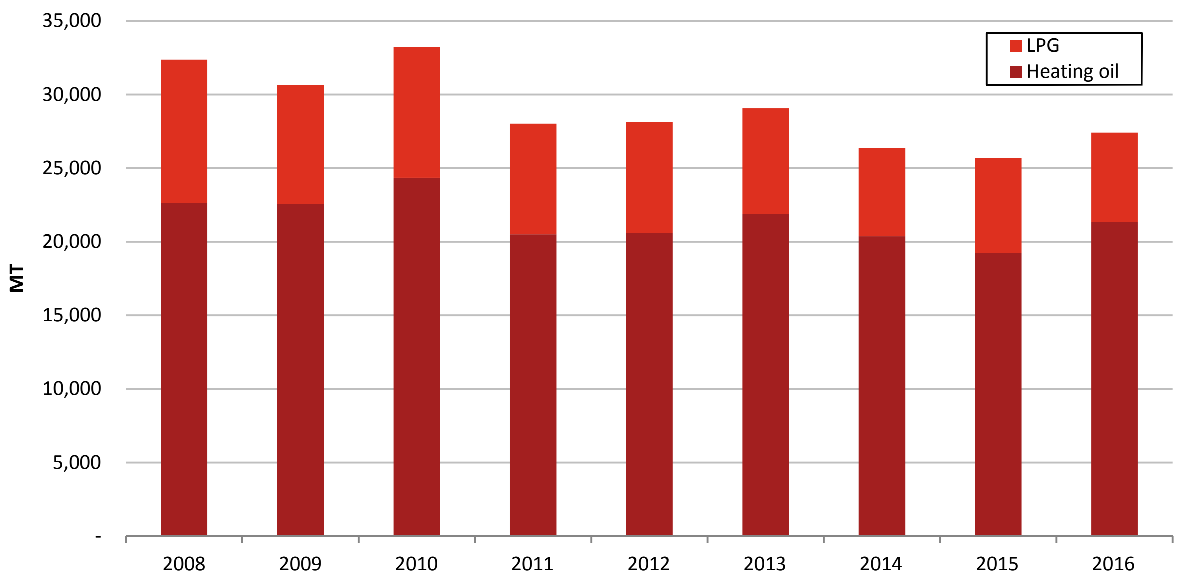
Guernsey has four sources of heating energy:

1) Heating oil – we have assumed that this is represented by all volumes of kerosene imported to Guernsey, except for volumes used as aviation fuel;
2) Gas oil – we have assumed a demand of around 9.5m litres in 2016 following discussions with RUBiS and CI Fuels;
3) Electricity – following discussions with GEL, we estimate heating demand for electricity at around 180 GWh;
4) LPG – we have assumed that all LPG imports are used for heating. As discussed in the Road Transport section 2.1, LPG demand for autogas vehicles is forecast to be small.

## *Historical heating demand*

We are not able to show size of the total heating market prior to 2016 due to uncertainty around gas oil and electricity demand. However, we can look at demand for LPG and heating oil, which together accounted for 56% of heating demand in 2016.

**Figure 3.12: Demand for heating oil and LPG in Guernsey, 2008-2016**



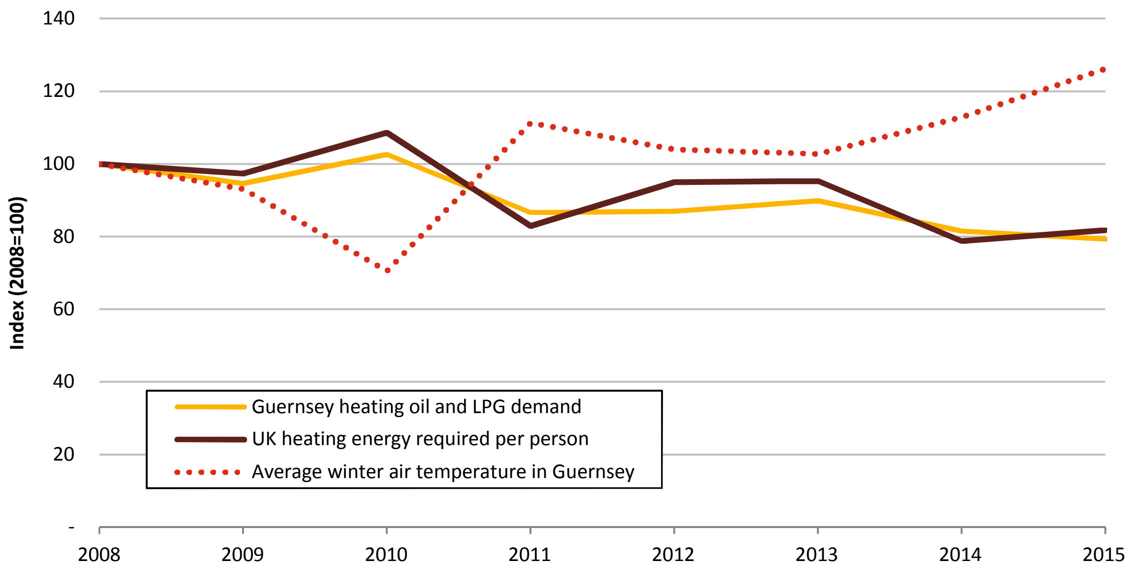

*Source: Guernsey Customs & Excise*

| | CAGR 2008-2016 |
|---|---|
| **Heating oil** | -0.7% p.a. |
| **LPG** | -5.7% p.a. |
| **Total** | -2.1% p.a. |

Total demand for both heating oil and LPG has trended broadly down, punctuated by occasional years of higher demand. The rate of decline in LPG has been greater than that in heating oil. Guernsey Gas told us the decline in LPG was due to greater residential insulation, milder weather and the improving efficiency of gas boilers.

Total demand for heating oil and LPG combined has followed a similar trend to total heating demand in the UK. The chart below shows a close relationship between the total demand in the two markets. It also shows that the years of strong demand coincided with particularly cold winters, and that years of weak demand coincided with warmer winters. In particular, in 2010 a drop in average air temperatures in January, February and December meant the Guernsey population used more heating oil and LPG for heating than in any other year in the sample.

**Figure 3.13: Guernsey heating oil and LPG demand against UK heating demand per person and average winter temperature in Guernsey, 2008-15**

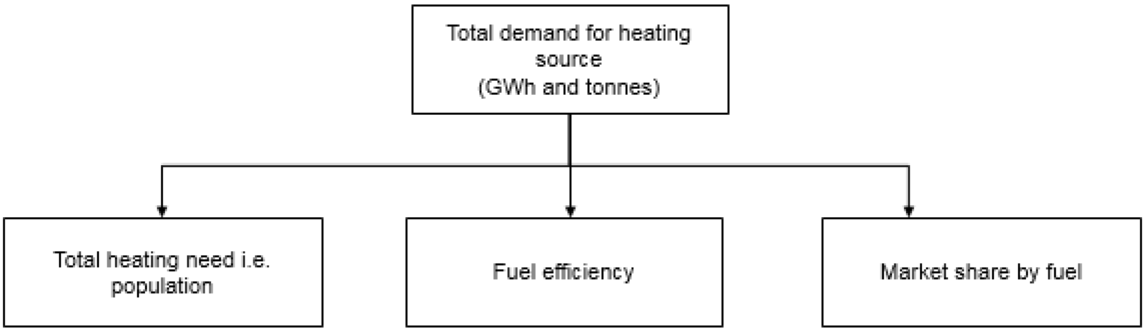



*Source: Guernsey Customs & Excise, Guernsey Policy & Resources Committee, UK Department for Business, Energy & Industrial Strategy*

## 3.2.3 Forecast methodology and assumptions

We apply the three fundamental drivers of hydrocarbon demand to the road transport segment as shown below.

**Figure 3.14: Heating fuel demand drivers**




The underlying need is the total demand for space heating, water heating and cooking, which we assume is proportional to population, but can also vary according to the weather. Fuel efficiency includes improvements in boiler efficiency as well as in home insulation. The market share by fuel is the proportion of total heating energy demand met by heating oil, gas oil, LPG and electricity.

In addition to the above underlying drivers, we have also considered a 'toggle' to demonstrate the possible impact of particularly cold winter on heating fuel demand.

### *Total heating need*

We have used Guernsey's population projections presented in Section 1.3 as the basis for our forecast of total heating need.

Demand for heating is also sensitive to changes in average winter temperatures. Guernsey experienced an average winter temperature in 2010 of 5.8°C, against an average of 8.5°C 2008-2015. This created an 8.0% increase in heating oil demand and a 9.8% increase in LPG demand from 2009. The UK experienced a similarly cold winter in 2010, which increased UK heating demand by 11.5%.

Likewise, the higher average winter temperature in 2011 of 9.2°C meant that volumes reduced by 15.8% for heating oil and 15.2% for LPG versus 2010.

It is not possible for us to predict average winter temperatures over the forecast period, so we have introduced an event 'toggle' to illustrate the impact of a cold winter in any given year. Using the winter of 2010 as a benchmark for the effect of a cold winter on Guernsey, we have included a 'toggle' in the forecast model that shows a 10% increase in demand for all heating sources to represent a particularly cold winter.

### *Fuel efficiency*

Figure 3.13 showed that the average amount of heating energy used per person in the UK and Guernsey declined by around -3% p.a. between 2008 and 2015. This decline in demand is due to improving heating efficiency. For example, average boiler efficiency in the UK increased from 49% in 1970 to around 82.5% in 2013. In addition, condensing boilers made up only 7% of gas and oil boilers in the UK in 2005 but by 2011 they represented nearly half of all boilers. Condensing boilers are on average 10-12% more efficient than traditional boilers. In parallel, the number of households with 'full insulation' in the UK has grown from 3% in 1987 to more than 25% in 2011.

Guernsey Gas has confirmed that efficiency gains in Guernsey have broadly followed trends in the UK, despite there currently being no government policies in place to encourage greater insulation of houses or boiler replacement in Guernsey.

Given that the historical efficiency gains appear to have been very similar in Guernsey to in the UK, we have assumed that forecast efficiency gains in Guernsey will continue to be the same as those in the UK, as forecasted by the National Grid.

National Grid forecasts anticipate continuing efficiency improvements driven by improvements in insulation (particularly solid wall insulation), installation of heat pumps, and use of district heating in new builds

National Grid presents four different forecasts for home heating efficiency, representing four different scenarios for energy demand based on different levels of economic prosperity and environmental concern. Please see Appendix 3.1 for more details.

We have used these forecasts to form our scenarios as follows:

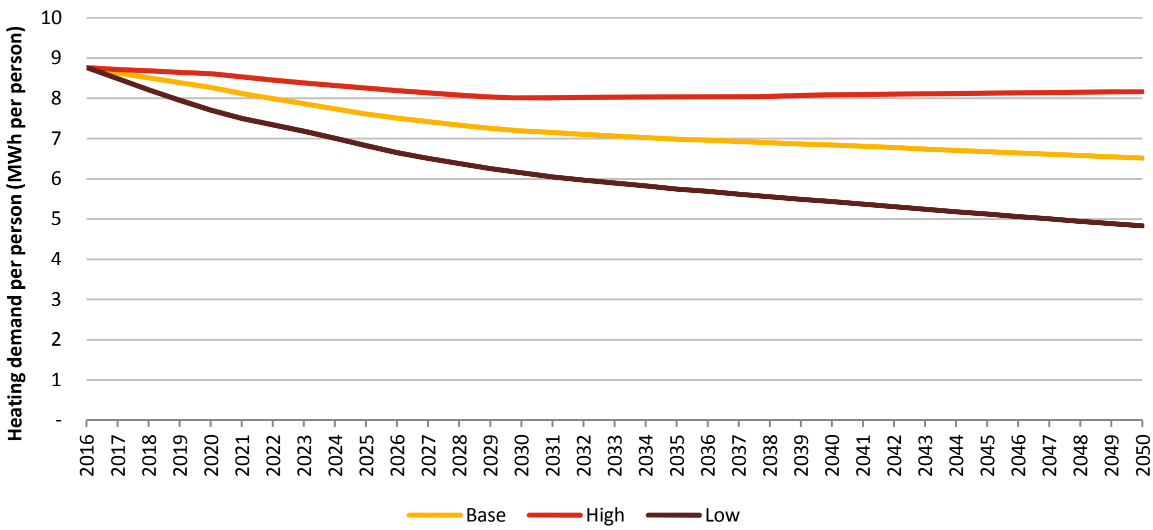
- Our base case uses the average of all four National Grid scenarios for heating efficiency

- Our low case uses the 'Gone Green' scenario, which represents a case where consumers are willing and able to invest in energy saving products. There may also be some district heating in new build developments and some uptake in newer technologies such as heat pumps.
- Our high case uses the 'No Progression' scenario, which represents a slow uptake of efficiency saving measures and therefore heating technology is largely unchanged from 2016.

The National Grid forecasts extend to 2040. For the last 10 years of our forecasts, we assume that the annual growth rate from 2031-2040 continues.

Overall, our analysis shows that heating efficiency is expected to improve over the forecast period but at a slower rate than historically. This is in line with the experience in the UK, where efficiencies have improved so much in recent years that further gains at the same rate become more difficult.

**Figure 3.15: Heating efficiency in Guernsey, 2016-2050**




| | CAGR | |
|---|---|---|
| | **2008-2015*** | **2016-2050** |
| **Base** | -2.6% p.a. | -0.9% p.a. |
| **High** | -2.6% p.a. | -0.2% p.a. |
| **Low** | -2.6% p.a. | -1.7% p.a. |

*UK figures

## *Market share by fuel*

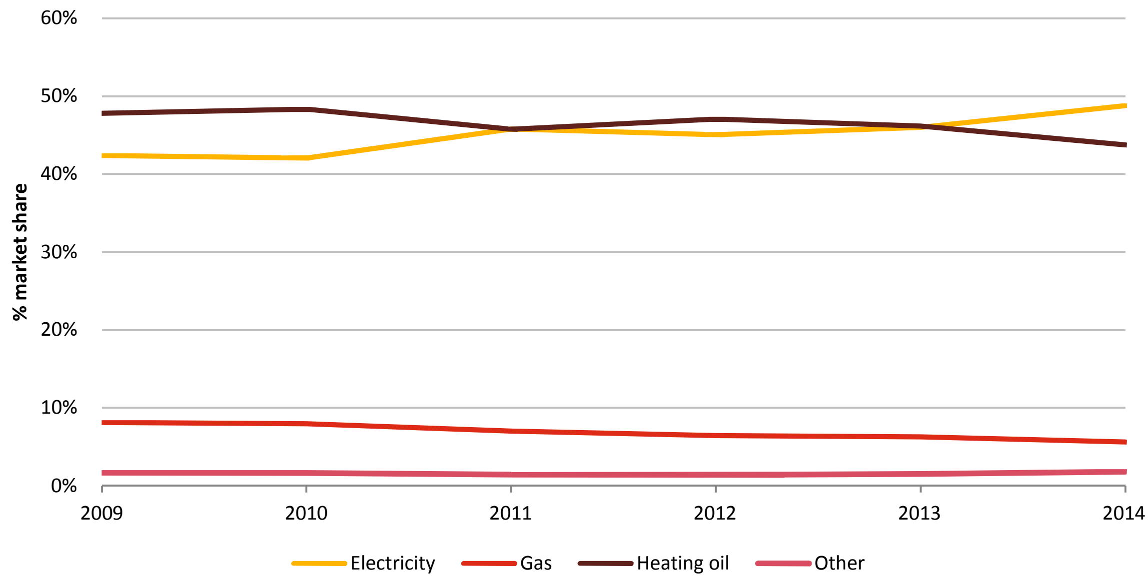
We have spoken to all of the major suppliers of energy on Guernsey to understand current and potential changes in market share by fuel. There is no single reliable dataset showing market share by fuel, so using information provided to us by some stakeholders and making assumptions in some areas, we have estimated the approximate split for 2016.

There is competition between these different fuels for market share. Consumers are free to switch between fuels, and several of Guernsey's energy providers have business plans anticipating market share gain from other fuels. Some of the energy providers we interviewed have shared details of their own forecasts which we have been able to assess in aggregate.

Despite competition in the market, we understand that switching rates tend to be very low. Data is available for Jersey, which shows that the market share of each fuel on Jersey has changed very little over the period 2009-2014. Barriers to more rapid switching include:

- Switching costs, considering that changing fuels may require a change in boiler and/or additional domestic appliances; switching decisions are most often made when a boiler is due for replacement
- Consumer preference for a particular fuel type
- Lack of clarity about the relative running costs of different fuel types
- Lack of consumer appetite or interest in switching fuel

**Figure 3.16: Jersey total household energy demand market shares (includes lighting and appliances demand), 2009-2014**




*Source: Jersey Energy Trends 2011, Jersey Energy Trends 2011-2014*

We understand from several stakeholders on Guernsey that gas is considered the most expensive fuel for a typical household, followed by electricity, with heating oil being the cheapest source. There is, however, no evidence of a historical market share change driven by this pricing differential. We have not sought to model or forecast the cost of heating a property using each fuel.

The National Grid forecasts for the UK anticipate an increase in the share of electricity across all of their scenarios, mostly at the expense of gas, which is the dominant hydrocarbon for residential and commercial heating. In the UK, heating a property using electricity is approximately 31% more expensive than using gas, which is mains-fed natural gas and therefore very cost effective. A direct comparison with Guernsey is difficult as the starting mix is different – Guernsey has a more fragmented set of hydrocarbon sources and a higher share of electricity – but this UK forecast does indicate that electricity is expected to gain share despite it being a more expensive fuel.

Considering all the above we have developed our scenarios as follows:

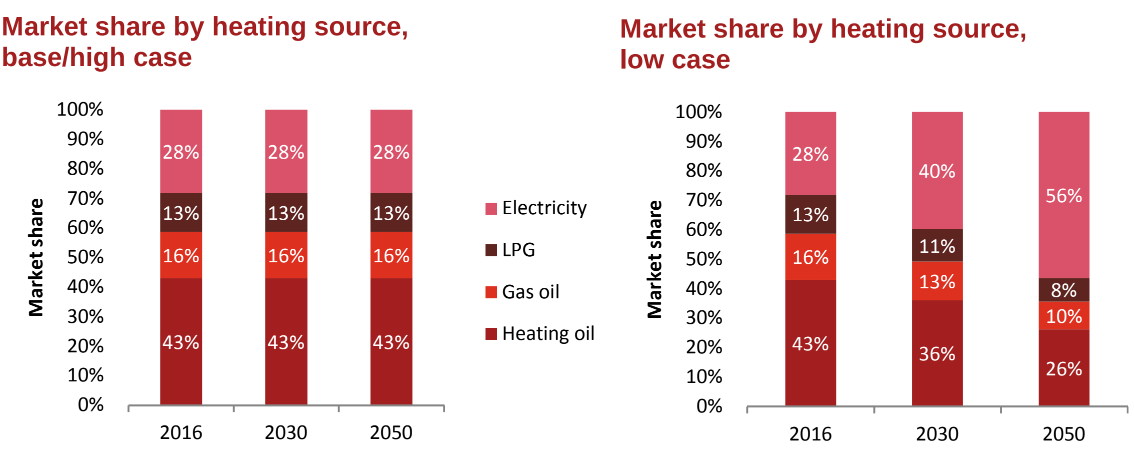
- Our base case assumes no change in fuel mix. Despite a price differential between fuels, the historical mix has stayed relatively constant.

- Our high fuel case also assumes no change in fuel mix. We have not recommended a scenario where electricity loses market share given the forecasts for the UK and given GEL is government-owned.
- Our low fuel case assumes that electricity doubles its market share to 56% by 2050. This reflects a similar trend to that expected in the UK, driven by an increased uptake of heat pumps and electrical storage heaters, and a general trend away from fossil fuels such as gas and heating oil.

| | **Population** | **Heating source market share** | **Heating efficiency (by National Grid scenario)** |
|---|---|---|---|
| **Base** | Policy & Resources population projection with +150 migration | Market shares fixed at 2016 levels | Average of all four National Grid scenarios |
| **High** | Policy & Resources population projection with +200 migration | Market shares fixed at 2016 levels | Low economic growth and little focus on environmental issues ("No Progression") |
| **Low** | Policy & Resources population projection with +100 migration | Electricity market share doubles to 56% by 2050, taking share equally from LPG, heating oil and gas oil. | High economic growth and high focus on environmental issues ("Gone Green") |

These assumptions lead to the following market shares for each heating source:

**Figure 3.17: Market share by heating source, 2016-2050**




## *Cold winter 'toggle'*

We have illustrated the impact of a particularly cold winter, using the example of 2010. The below table shows the illustrative impact of a similarly cold winter in 2020, 2030, 2040 or 2050.

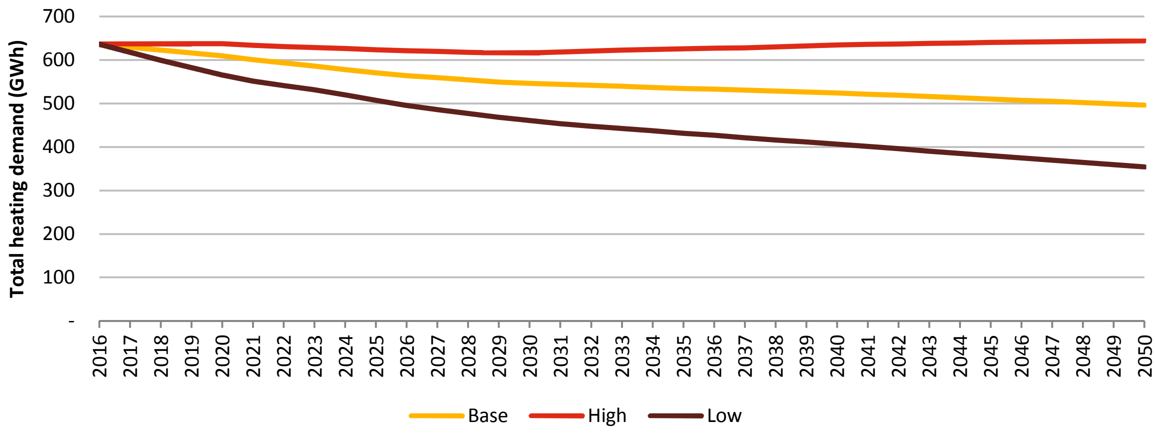
| | Additional heating demand (MT) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Heating oil | | | Gas oil | | | LPG | | | Total | | |
| | Base | High | Low | Base | High | Low | Base | High | Low | Base | High | Low |
| **2020** | 2,041 | 2,135 | 1,807 | 763 | 798 | 675 | 581 | 608 | 515 | 3,386 | 3,540 | 2,997 |
| **2030** | 1,830 | 2,065 | 1,294 | 684 | 772 | 483 | 521 | 588 | 368 | 3,035 | 3,425 | 2,145 |
| **2040** | 1,756 | 2,126 | 984 | 656 | 795 | 368 | 500 | 606 | 280 | 2,912 | 3,526 | 1,633 |
| **2050** | 1,661 | 2,158 | 721 | 621 | 806 | 270 | 473 | 615 | 205 | 2,755 | 3,579 | 1,196 |

## 3.2.4 Conclusions

### *Total heating energy demand*

Our base case shows a gradual decline in energy required for heating of -0.7% p.a. 2016-2050, implying a drop of -22% over the period. Our low case shows a faster decline of -1.7% p.a. – a total drop of -44% and our high case shows total energy required that is essentially flat.

**Figure 3.18: Total heating demand in Guernsey, GWh, 2016-2050**

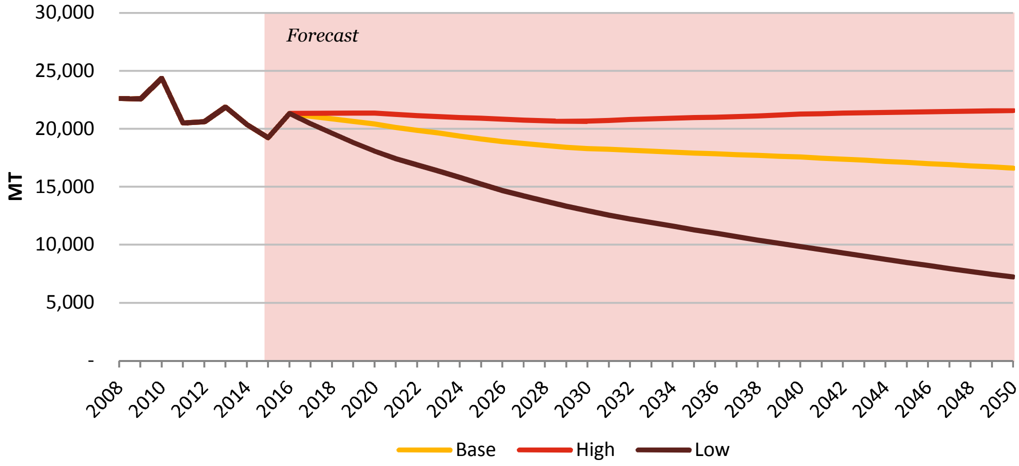



| | CAGR 2016-2050 |
|---|---|
| **Base** | -0.7% p.a. |
| **High** | 0.0% p.a. |
| **Low** | -1.7% p.a. |

### *Heating oil demand*

Heating oil demand rapidly declines in both our base case and low case 2016-2050 compared to historical averages. This is largely due to improving heating efficiencies and loss of market share to electricity in our low case. By contrast, our high case shows relatively steady demand due to a slower uptake of efficiency saving technologies and no loss of market share.

**Figure 3.19: Heating oil demand by scenario, 2008-2050**

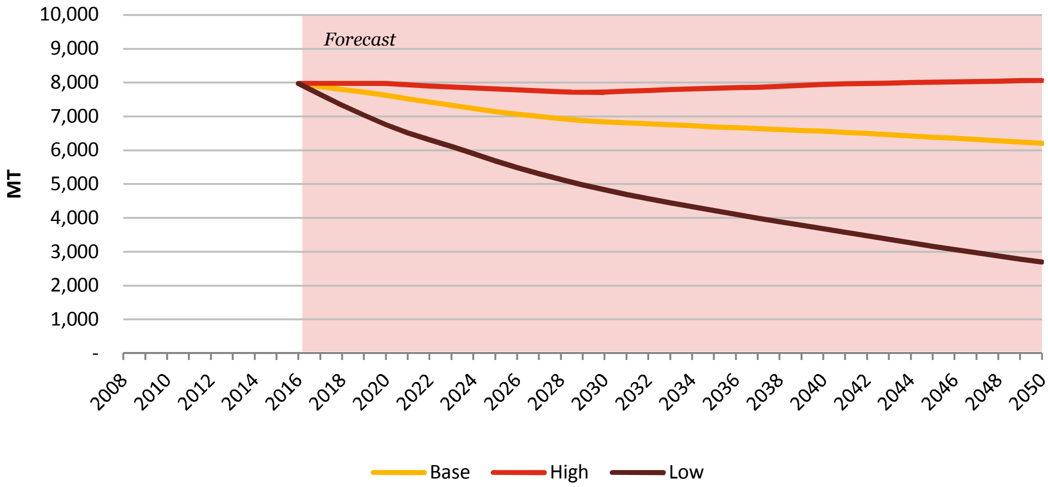



| | CAGR | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **Base** | -0.7% p.a. | -0.7% p.a. |
| **High** | -0.7% p.a. | 0.0% p.a. |
| **Low** | -0.7% p.a. | -3.1% p.a. |

## *Gas oil demand*

Our gas oil forecasts follow demand trends for heating oil. Please note that historical gas oil figures are not available.

**Figure 3.20: Gas oil demand by scenario, 2008-2050**

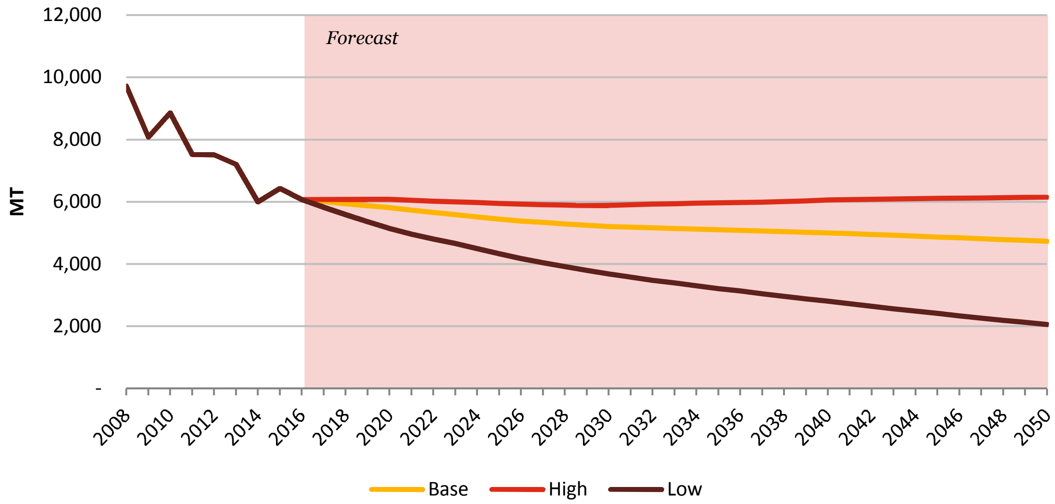


| | CAGR | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **Base** | N/A | -0.7% p.a. |
| **High** | N/A | 0.0% p.a. |
| **Low** | N/A | -3.1% p.a. |

## *LPG demand*

In our base case, the rate of decline in LPG demand slows to -0.7% p.a. and our high case shows very little change in LPG demand from 2016. However, our low case shows a continued drop off by -3.1% p.a., which is slightly slower than recent historical numbers.

**Figure 3.21: LPG demand by scenario, 2008-2050**




| | CAGR | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **Base** | -5.7% p.a. | -0.7% p.a. |
| **High** | -5.7% p.a. | 0.0% p.a. |
| **Low** | -5.7% p.a. | -3.1% p.a. |

# 3.3 Electricity demand

## 3.3.1 Executive Summary

- We have defined electricity demand as the sum of demand for residential light & appliances, heating, commercial demand and EV demand. Electricity can be imported via an interconnector from France, or generated on-island using HFO or renewables;
- There was strong growth in electricity demand from 2000-2012, with a plateau 2013-2016. HFO demand can be volatile, with a prominent spike in 2012;
- The key drivers of demand for electricity include economic growth, efficiency, and substitution. HFO demand rapidly increases when Guernsey is unable to import energy using the interconnector;
- In our base case, the total electricity market declines by CAGR -0.6% p.a. This is primarily due to declines in residential lighting and appliances, and commercial demand. Using a 'toggle' we have shown the effect of interconnector disruptions on HFO demand;
- In our low case electricity demand drops by -0.6% p.a. (similar to our base case) but our high case shows a slightly more gradual decline of around -0.2% p.a.
- We have assumed HFO demand is flat at 13,200MT throughout the forecast period in all scenarios, as per Guernsey Electricity (GEL) forecasts. We have used a 'toggle' where this demand drops to 6,700MT if a second interconnector is installed;
- However, most significantly, if the interconnector fails we have assumed that 75% of total electricity demand is generated on-island. This creates a large increase in HFO demand that varies by scenario.

## 3.3.2 Historical demand trends

We have defined electricity demand as the sum of demand for residential light & appliances, heating, commercial demand and EV demand.

GEL is the sole commercial supplier of electricity to the island. It supplies electricity that is sourced either through an interconnector that transmits electricity from France, or that is generated in GEL's on-island generators.

Electricity that is supplied through the interconnector requires no hydrocarbons imports. The on-island generation is a combination of HFO and gas oil generators. We have assumed all HFO consumption on Guernsey is used for electricity generation.

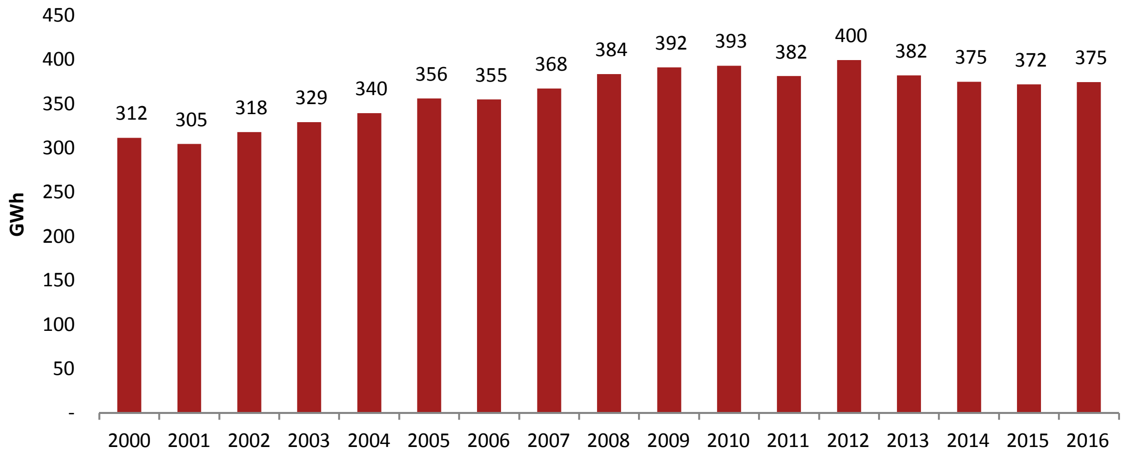
There is currently no official policy to construct a second interconnector. However, GEL has considered the construction of a second interconnector by 2023 in its base case projections.

### *Total electricity demand*

Total demand for electricity has followed two broad phases over the last 15 years:

- From 2001-2012 there was a steady increase in electricity consumption. GEL stated that this was due to increased demand for heating and increased prevalence of electrical appliances;
- From 2013, demand has plateaued. Although the prevalence of electrical appliances has continued to increase they have also become more efficient, which has created a net effect of near-zero.

**Figure 3.22: Total electricity demand in Guernsey, 2000-16**




*Source: GEL*

Please note we do not have data to show historical electricity usage split by demand type e.g. residential light & appliances, heating, commercial demand and EV demand.

## *Electricity supply by source*

Prior to 2001, all electricity was generated on island. Construction of the interconnector to import electricity from France was completed in 2001.

On average since 2001 on-island generation has accounted for 35% of electricity supplied. However, the mix of electricity supplied via the interconnector compared with generated on island has varied significantly over the last 15 years.

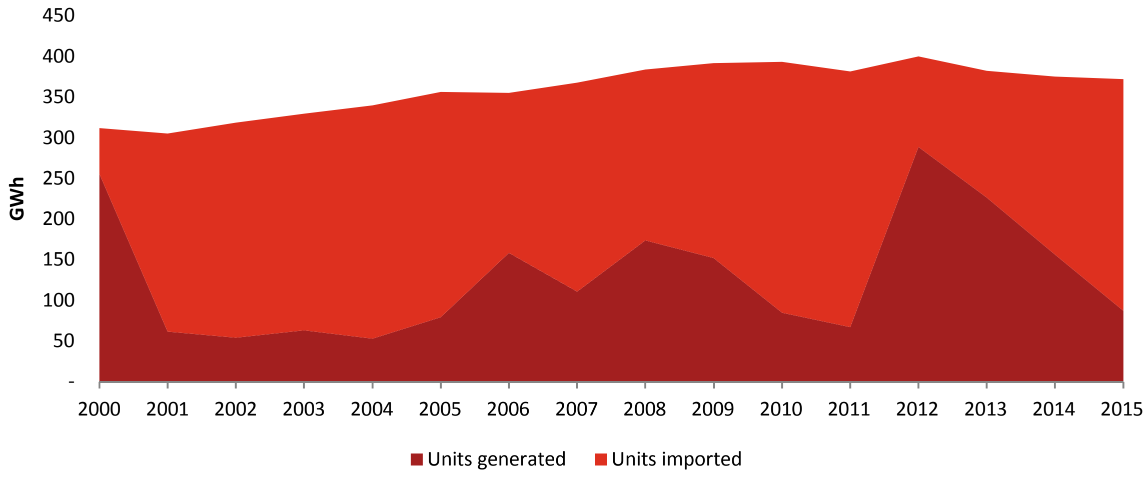
Whether Guernsey supplies electricity generated on-island or supplied via the interconnector is currently decided on least cost of dispatch. Typically, this means that Guernsey maximises receipt of electricity from the interconnector unless the price of HFO declines to a point at which on-island generation becomes more cost effective.

The States of Guernsey also has a policy to ensure a high level of redundancy to ensure continuity of supply in the case of failure in any sources of electricity supply. This policy is termed “N-2”, meaning that GEL should maintain the ability to supply all of the island’s electricity needs even if the two largest supplies of electricity are disrupted. The capability to generate electricity on-island is central to achieving this policy.

The policy and other issues can cause significant fluctuations in the proportion of electricity generated on-island, and therefore the quantity of hydrocarbons required. For example, in 2012, the interconnector failed for a period of six months, creating a jump in demand for on-island generation. On-island generation jumped fourfold from 67 GWh in 2011 to 289 GWh in 2012.

This volatility is one of the largest uncertainties in the island’s overall hydrocarbon demand profile, and makes forecasting hydrocarbon volumes difficult. Overall, the supply of HFO and gas oil to GEL is one of the biggest ‘swing factors’ in the overall demand forecast, as demand can change significantly from one year to the next.

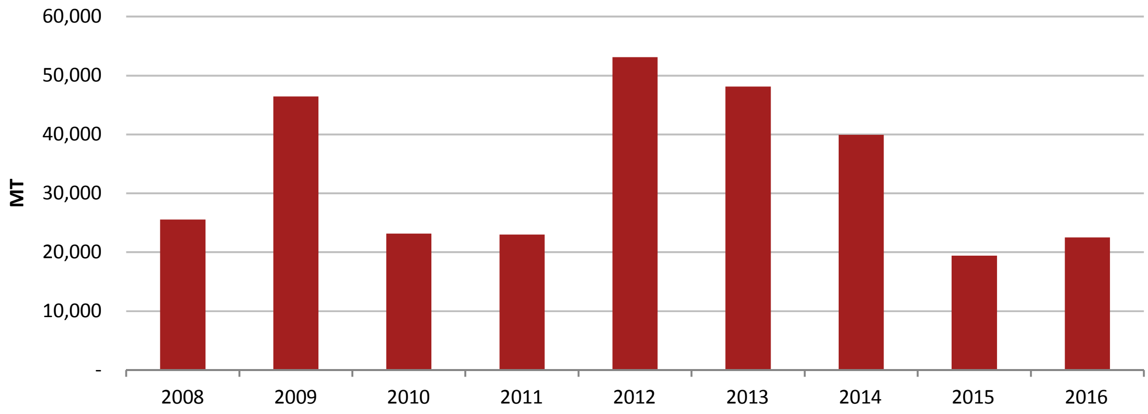
Figure 3.23: Electricity supply by source (GWh), 2000-2016




*Source: GEL*

For on-island generation, GEL has seven baseload generators that can use either HFO or gas oil and a further three turbines running on gas oil. Gas oil is typically more expensive then HFO and generates less electricity per tonne, but gas oil turbines can be turned on more quickly than HFO generators. GEL therefore uses its gas oil generators as back-up and peaking plant, typically used only occasionally during periods of peak demand or if HFO generators are unavailable.

Figure 3.24: HFO imports to Guernsey, 2008-16

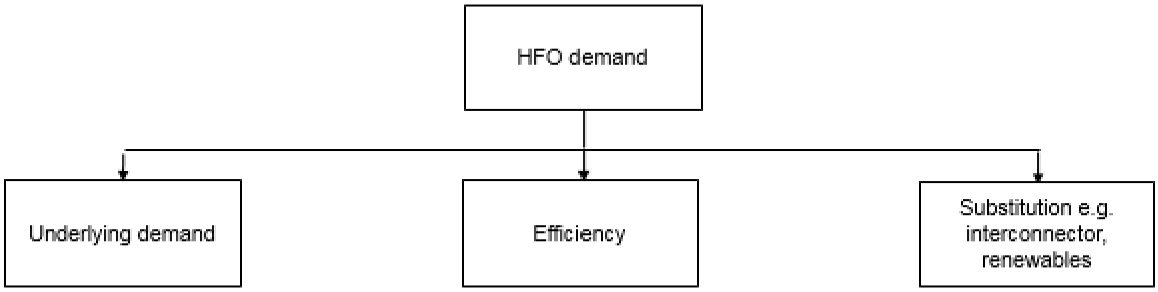



*Source: Guernsey Customs & Excise*

We do not have data on the amount of gas oil used for electricity generation. Our understanding is that GEL has 1,000MT of storage for gas oil versus 13,000MT for HFO. We have not therefore modelled gas oil demand linked to power generation.

### 3.3.3 Forecast methodology and assumptions

We apply the three fundamental drivers of hydrocarbon demand to the electricity segment as shown below.

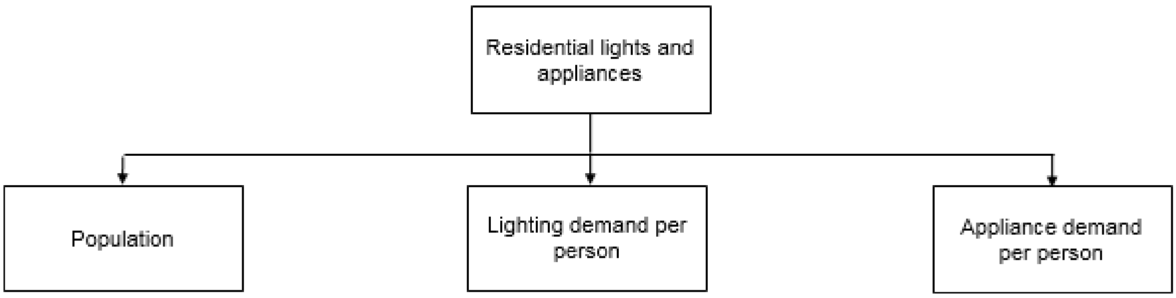



The underlying demand is the total demand for electricity for residential, commercial and industrial demand. It also therefore includes electricity demand for heating purposes and for electric vehicle charging, which have been modelled in previous sections and are included here to understand how they translate to hydrocarbon demand.

Efficiency represents the efficiency of the on-island power generation. In this case, we assume that the efficiency of GEL's generation fleet does not change over the period of the forecast. We have assumed that each tonne of HFO generates 4.5 MWh from 2016-2050. Note that the efficiency of the end appliances (lighting etc.) is considered in underlying demand.

#### *Underlying demand*

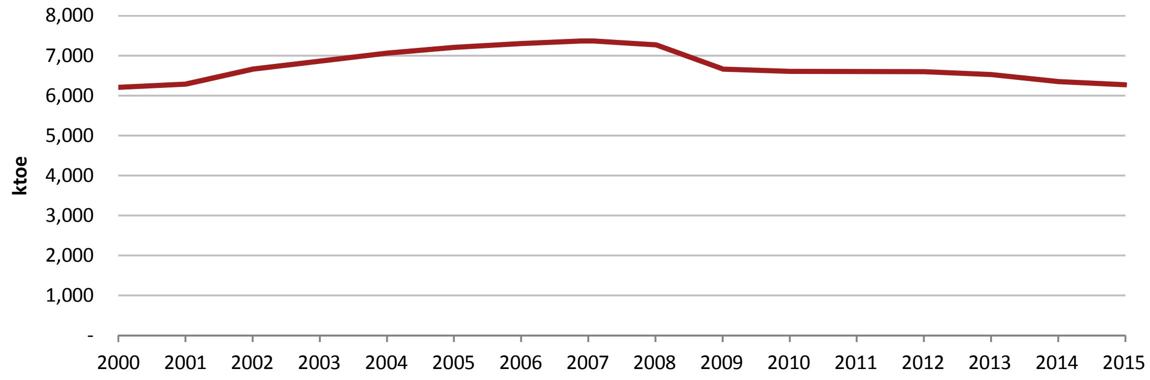
*Residential lights & appliances*




To forecast residential lighting and appliance demand in Guernsey, we have found the lighting and appliance demand per person in Guernsey in 2016, used National Grid projections for the UK market to forecast how this demand is expected to grow in future and multiplied the result by the projected population within Guernsey.

Electricity demand for lights and appliances in the UK rose steadily at 2.0% p.a. to 2008. Demand then declined markedly in 2009, due to the effects of the recession. Since then, demand has not returned to growth, instead declining gradually at -1.0% p.a., which the UK government ("*United Kingdom Housing Energy Fact File, 2013*") believes is due principally to the increasing efficiency of lighting and appliances. The Boston Consulting Group has estimated that LEDs will account for 60% of the consumer luminaires market by 2020.

**Figure 3.25: UK lighting and appliance demand, 2000-15**




*Source: UK Department for Business, Energy & Industrial Strategy*

GEL confirmed that the UK is a good benchmark for trends in appliance efficiency in Guernsey, although it notes that the demand plateau happened 3-5 years later in Guernsey (2011-13) than in the UK.

Based on discussions with GEL, we estimate lighting and appliance demand to be in the region of 1.58 MWh/year per person on Guernsey. This compares to demand in the UK of around 1.40 MWh/year.

Our assumptions on improvements in lighting and appliance efficiency are taken from forecasts for the UK by National Grid plc, which presents four different forecasts for home lighting and appliance efficiency, representing each of the four different energy scenarios presented in appendix section 3.1. We have used these forecasts to form our scenarios as follows:

- Our base case uses the average of all four National Grid scenarios for lighting and appliance efficiency
- Our low case uses the ‘Gone Green’ scenario, which represents a case where consumers are willing and able to invest in energy saving products.
- Our high case uses the ‘No Progression’ scenario, which represents a slow uptake of efficiency saving measures and therefore lighting and appliance technology is largely unchanged from 2016.

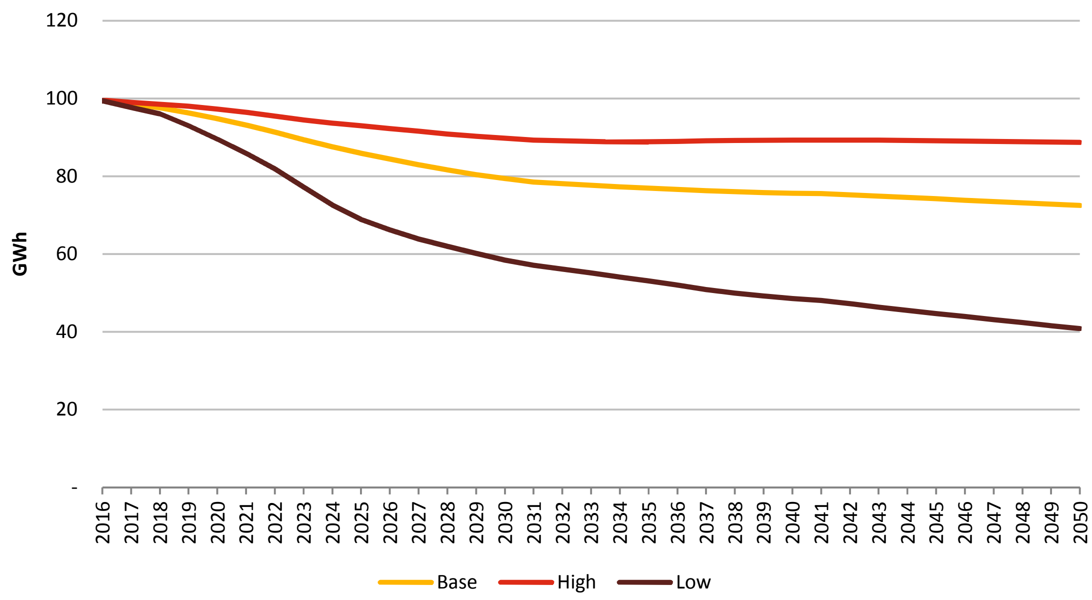
In all scenarios, National Grid expects that increasing efficiency – most notably in lighting – will continue to outweigh the increasing volume of appliances found in an average home.

The National Grid forecasts extend to 2040. For the last 10 years of our forecasts, we assume that the annual growth rate from 2031-2040 continues.

The percentage change in the UK’s projected demand per person for residential lights and appliances is assumed to be identical to the change in Guernsey.

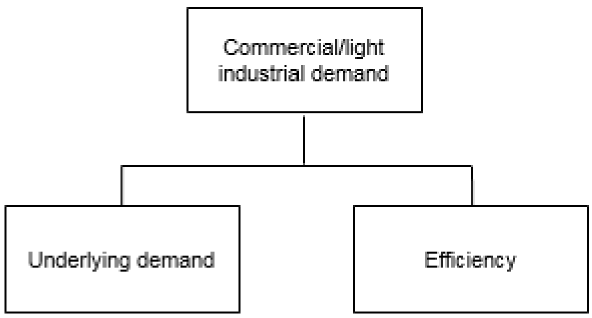
Using these assumptions, we forecast that electricity demand for residential lighting and appliances is forecast to decline in all scenarios. Our base case shows a decline of -0.9% p.a. through to 2050.

### Figure 3.26: Total residential lighting and appliances electricity demand, 2016-2050




| | CAGR 2016-2050 |
|---|---|
| **Base** | -0.9% p.a. |
| **High** | -0.3% p.a. |
| **Low** | -2.6% p.a. |

## *Commercial and industrial demand*




We have forecast commercial and light industrial demand by estimating the commercial and light industrial demand for electricity on Guernsey in 2016 and forecasting future growth with reference to the National Grid forecasts for commercial electricity demand in the UK.

GEL has suggested a figure of 180GWh for commercial and light industrial electricity demand in 2016. This includes heating, lighting and appliances. They have stated that residential and commercial/light industrial demand make up around 50% each of total demand.

According to States of Guernsey data, 58% of Guernsey's output comprises business services, finance, and information services. We have spoken to the States of Guernsey Economic Development committee which has stated that no material changes in the composition of Guernsey's economy are forecast – i.e. that there are no policies to encourage growth in energy-intensive industries such as manufacturing.

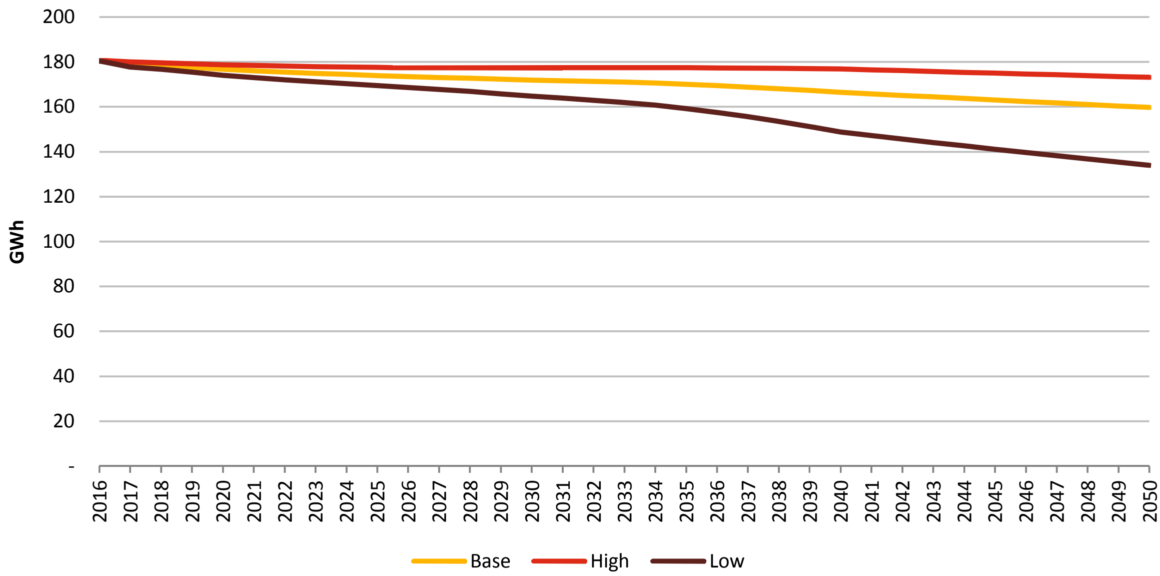
We have used National Grid assumptions for electricity required for commercial and light industrial demand in the UK (please see the 'Heating' section 2.2 for more information). We have used these forecasts to form our scenarios as follows:

- Our base case uses the average of all four National Grid scenarios for commercial and light industrial demand per person
- Our low case uses the 'Gone Green' scenario, which represents a case where a focus on green issues and relative economic prosperity lead to an uptake in heat pumps
- Our high case uses the 'No Progression' scenario, which represents the continuation of current efficiencies for commercial demand

The National Grid forecasts show that commercial electricity demand per person is likely to remain relatively flat, with only a modest drop to 2050 in our base and high cases. Our low case suggests a steeper improvement in average efficiencies, primarily due to the use of heat pumps.

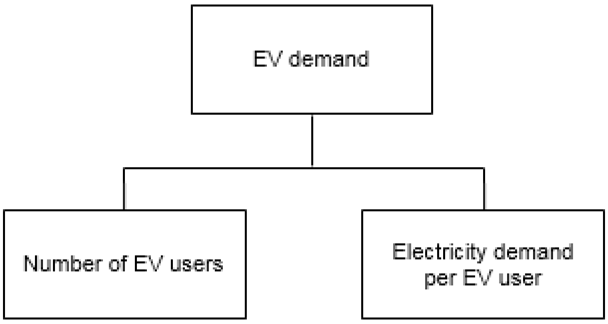
We therefore have the following forecast for commercial and light industrial demand:

**Figure 3.27: Commercial and light industrial demand by scenario**




| | CAGRs 2016-2050 |
|---|---|
| **Base** | -0.4% p.a. |
| **High** | -0.1% p.a. |
| **Low** | -0.9% p.a. |

*Electric vehicles*




In 'Road Transport' section 2.1 of this report, we forecast the number of EV users in Guernsey using population projections and EV uptake rates in the UK and Norway.

To estimate the electricity demand required per EV user, we have used National forecasts for how much electricity will be demanded by EVs according to their four scenarios. We have translated this into the amount of electricity needed per user of an EV.

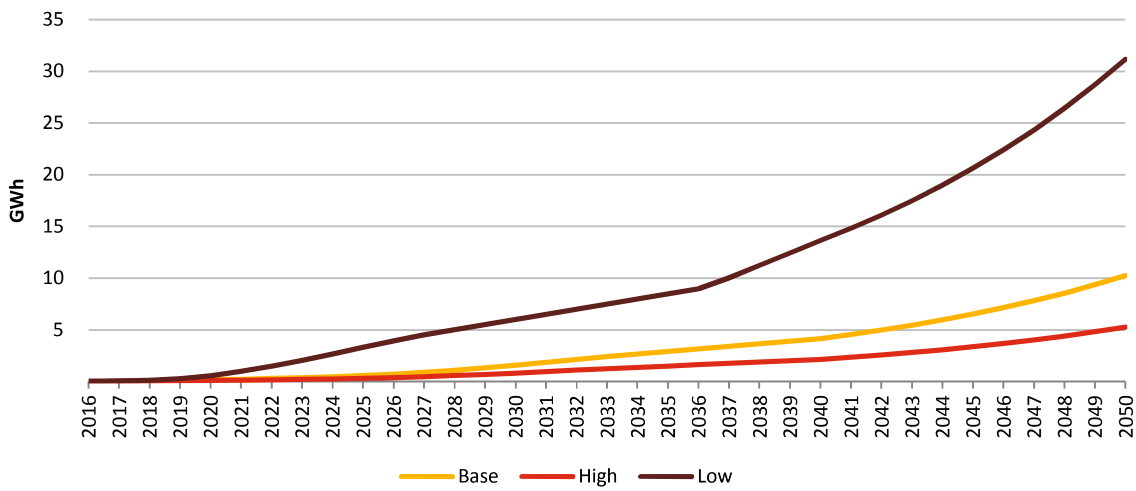
We have assumed that EVs require less energy in Guernsey compared to the UK due to slower average speeds and shorter average distances travelled per year. According to a report from 2007 ("*Energy Market Investigation, 2007*"), the average UK car travels 9,500 miles per year. With further analysis, the report concludes that a mid-case for car use in Guernsey would be 6,000 miles i.e. 63% of the UK distance. We have therefore decreased the energy demanded per user of an EV in Guernsey to 63% of the UK average.

National Grid forecasts estimate that average demand per EV user was 0.97 MWh/year in 2016. We have not taken a view on the future efficiency of EVs. It may be the case that EVs travel further distances over time that may increase electricity use for EVs over the forecast period. Furthermore, the National Grid suggests that smart meters and time-of-use tariffs may shift demand away from peak times, which may have some effect on electricity infrastructure.

However, for simplicity, we have used a flat efficiency for EVs in our forecast of 0.61 MWh/EV user. This is 63% of the UK average to reflect differences in average distances.

EV electricity demand is therefore forecasted as follows:

**Figure 3.28: EV electricity demand by scenario, 2016-2050**



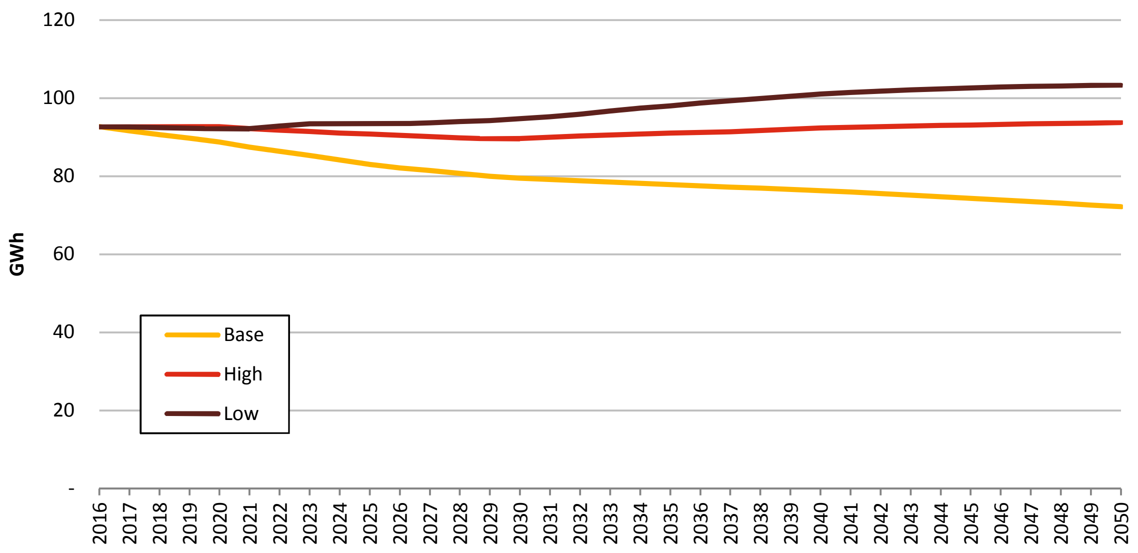
| | CAGR 2016-2050 |
|---|---|
| **Base** | 15% p.a. |
| **High** | 13% p.a. |
| **Low** | 20% p.a. |

### *Residential heating*

Please see the 'Heating' section 2.2 of this report for an explanation of how we arrived at our heating forecast. Electricity's market share is forecast to be flat in our base and high case, and double in size from 2016-2050 in our low case.

Following conversations with GEL, we have assumed that residential heating demand is 93 GWh in 2016. This results in the following forecast:

**Figure 3.29: Electricity demand for residential heating, 2016-2050**




| | CAGR 2016-2050 |
|---|---|
| **Base** | -0.7% p.a. |
| **High** | 0.0% p.a. |
| **Low** | 0.3% p.a. |

Commercial heating demand is dealt with in the commercial and light industrial demand section above.

## ***Substitution***

### *On-island generation by renewables*

According to GEL, renewables are unlikely to create a significant alternative to on-island generation or electricity received via the interconnector by 2050. There are currently no policy incentives to increase the uptake of renewables.

We have made the following assumptions using GEL's guidelines:

- Domestic renewables reduce demand by an additional 0.1% per year up to 2050, when the aggregate effect will be a 3% reduction in total electricity demand;
- We have assumed a grid level development of 0.5MWh is installed every five years, starting in 2022;
- There are no large scale renewables developments over the forecast period e.g. offshore wind farms, tidal energy installations or large solar developments.

### *Imports of electricity using the interconnector*

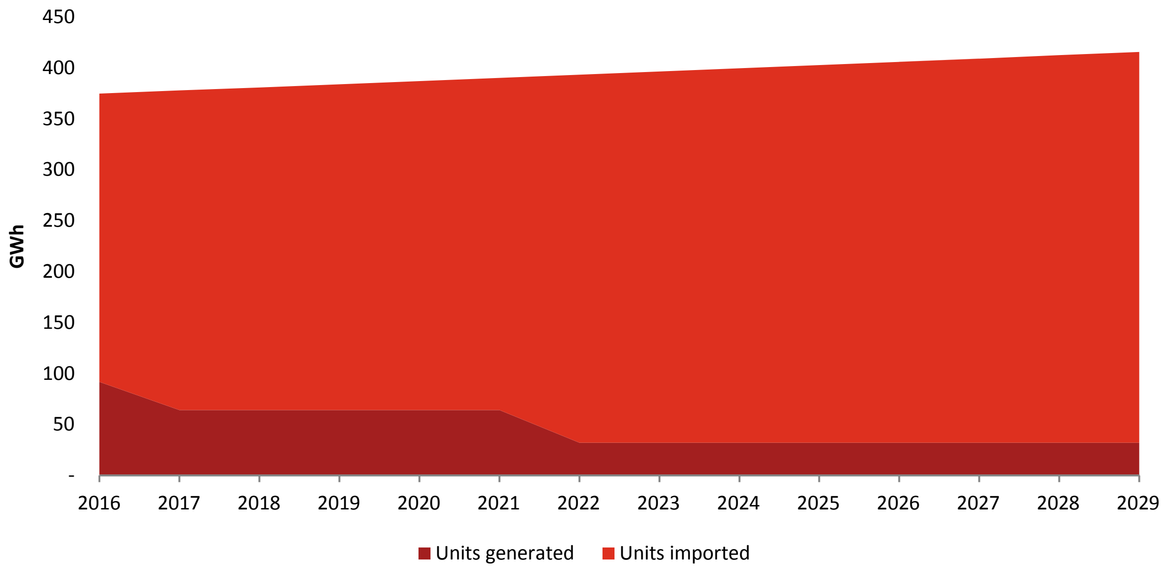
As stated, the volume of HFO that will be consumed on Guernsey is determined by how much electricity is imported using an interconnector.

Whether Guernsey receives electricity generated on-island or supplied via the interconnector is currently decided on least cost of dispatch. Typically, this means that Guernsey maximises receipt of electricity from the interconnector.

However, HFO consumption has historically increased rapidly when the interconnectors have been disrupted (such as in 2012). On average, 35% of electricity has been transmitted via the interconnector 2000-2015, with a peak in 2012 of 72%. During a disruption, GEL would need to generate electricity using HFO, which generates around 4.5 MWh per tonne.

GEL have supplied us with a forecast of their view of future on-island generation and electricity transmitted via the interconnectors. This is shown below.

**Figure 3.30: GEL forecast of electricity supply by source, 2016-2029**




*Source: GEL*

GEL has assumed 64GWh of on-island HFO generation 2016-2021, which equates to 13,200MT of HFO consumption. In 2022, on-island HFO generation is forecast to drop to 32GWh due to the installation of a second interconnector, which equates to 6,700MT of HFO consumption.

13,200MT is approximately in line with the lowest usage years since the interconnector was installed. It therefore assumes that there are no supply issues with the interconnector, such as in 2012.

GEL has also stated that 6,700MT is the minimum consumption of HFO needed to keep the generator fleet in good working order. However, GEL can only reduce consumption to this level if Guernsey has two operational interconnectors. It is worth noting that the construction of a second interconnector is not currently States of Guernsey policy.

We have therefore assumed flat demand of 13,200MT figure in all three scenarios up to 2050, when there are no interconnector disruptions. However, our forecast model uses two 'toggles':

- Where there are interconnector disruptions, we have assumed that 75% of electricity demand is met with on-island generation using HFO;
- If a second interconnector is installed, HFO demand drops to 6,700MT in years where there are no disruptions.

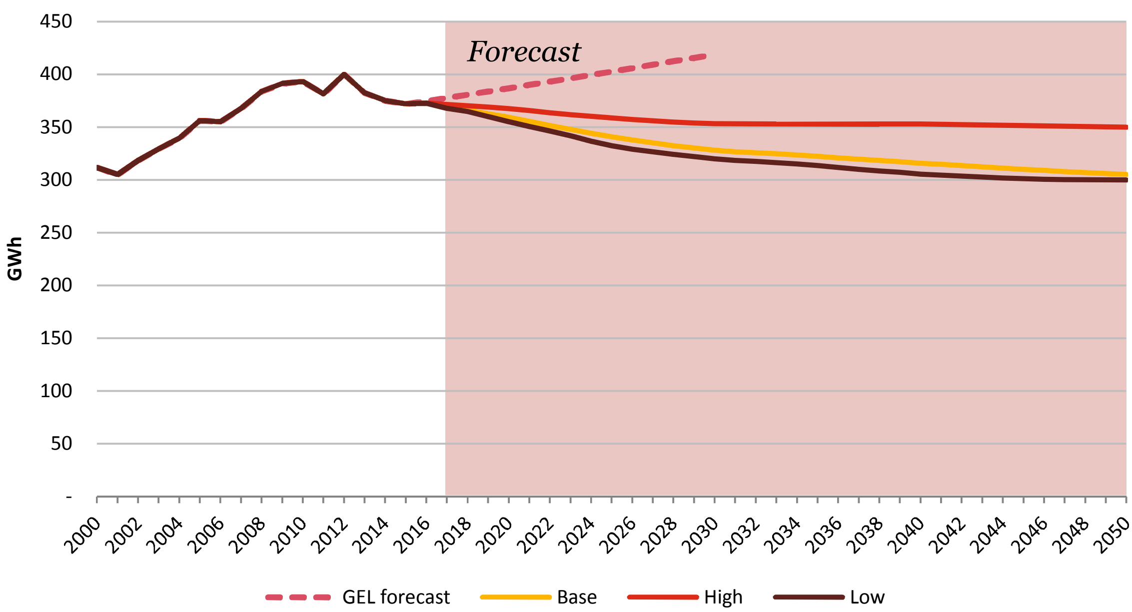
## 3.3.4 Conclusions

*Total electricity demand forecast*

On-island generation using HFO will represent the quantity of total electricity demand that cannot be supplied by the interconnector (and to a lesser extent, by on-island renewable generation). Therefore, we will first consider the size of the total electricity market.

GEL have provided us with a forecast of total electricity demand up to 2030. We have plotted this against our three scenarios below.

**Figure 3.31: Total electricity demand, 2001-2050**




| | CAGR | | |
|---|---|---|---|
| | **2000-2015** | **2016-2030** | **2031-2050** |
| **Base** | 1.2% | -0.9% | -0.4% |
| **High** | 1.2% | -0.4% | 0.0% |
| **Low** | 1.2% | -1.1% | -0.3% |
| **GEL forecast** | 1.2% | 0.8% | N/A |

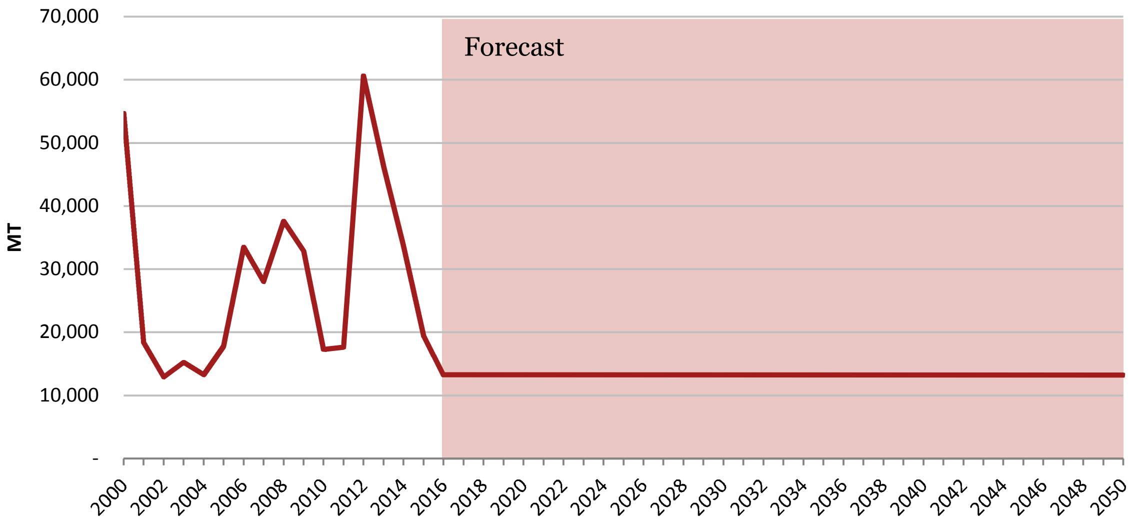
The GEL forecast is more positive than our scenarios up to 2030. This is likely to be due to a more rapid increase in electricity's market share of heating demand, and a larger total size of the heating market.

However, as discussed, the size of the total electricity market on its own does not inform us about how much HFO Guernsey will consume due to imports from the interconnector. We must therefore look at how much electricity will be generated using HFO versus how much electricity will be imported.

### *HFO demand assuming no disruptions to the interconnector*

Our HFO forecast assumes that there is one fully operational interconnector over the forecast period. We have therefore assumed 13,200MT of HFO consumption in all years in the forecast, as per GEL forecasts. All remaining demand is met via the interconnector.

**Figure 3.32: HFO demand, assuming no interconnector disruptions 2016-2050**



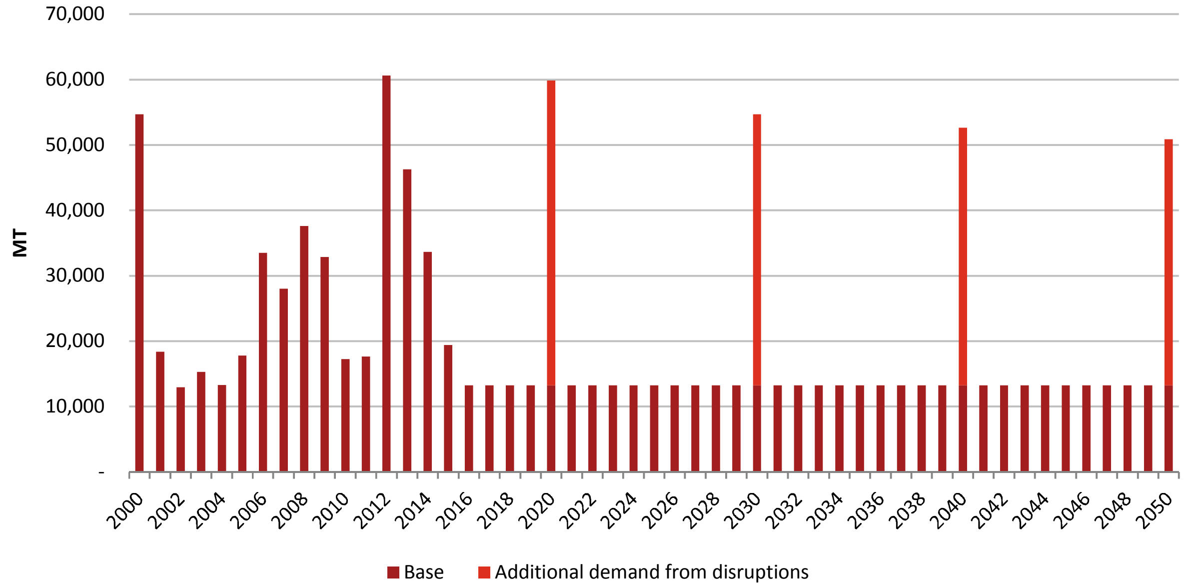

We have assumed that the introduction of a second interconnector would reduce HFO demand to 6,700MT, which we have expressed in the form of a toggle to our forecast model.

### *HFO demand assuming interconnector disruptions*

The quantity of HFO that Guernsey requires is equal to total electricity demand minus electricity supplied by the interconnector (and a small amount by on-island renewables). Therefore, HFO consumption may increase rapidly if there are disruptions to the interconnector. The size of the spike in HFO demand will relate to the total electricity demand of Guernsey.

We have illustrated the additional HFO required should there be a supply problem with the interconnector. In this case we have used our base case and assumed that on-island generation using HFO is responsible for 75% of the year's total electricity demand in selected years. An example is below.

**HFO demand, assuming 75% on-island generation in 2020, 2030, 2040 and 2050 - base case**



# 3.4 Aviation demand

## 3.4.1 Executive Summary

This section sets out forecasts of jet fuel and aviation gasoline (avgas) demand for aviation purposes in Guernsey.

*Jet fuel*

- Jet fuel is primarily used for commercial air transport in Guernsey;
- Demand for jet fuel has slowed since 2008, with sharp declines in 2008-11 and gradual decreases thereafter;
- The steep fall in demand was largely driven by price increases in Guernsey, where oil prices are relatively higher compared to the UK. For the most part, airlines can choose where to refuel;
- To forecast the amount of jet fuel required, we use a bottom-up approach of estimating the number of aircraft movements made in Guernsey, the amount of fuel required for each plane refuel and a jet fuel efficiency factor;
- In all three scenarios, the number of aircraft movements in Guernsey is assumed to be constant. However, our fuel efficiency assumptions for each scenario varies according to UK aviation forecasts;
- Our base scenario shows a gradual decline in jet fuel forecasts of 1.0% p.a. from 2017 to 2050, implying a total decline of 27% over the period;
- The low scenario presents the largest total decline at -31% (-1.1% p.a.), while our high scenario forecasts a -25% decline (0.9% p.a.).

*Avgas*

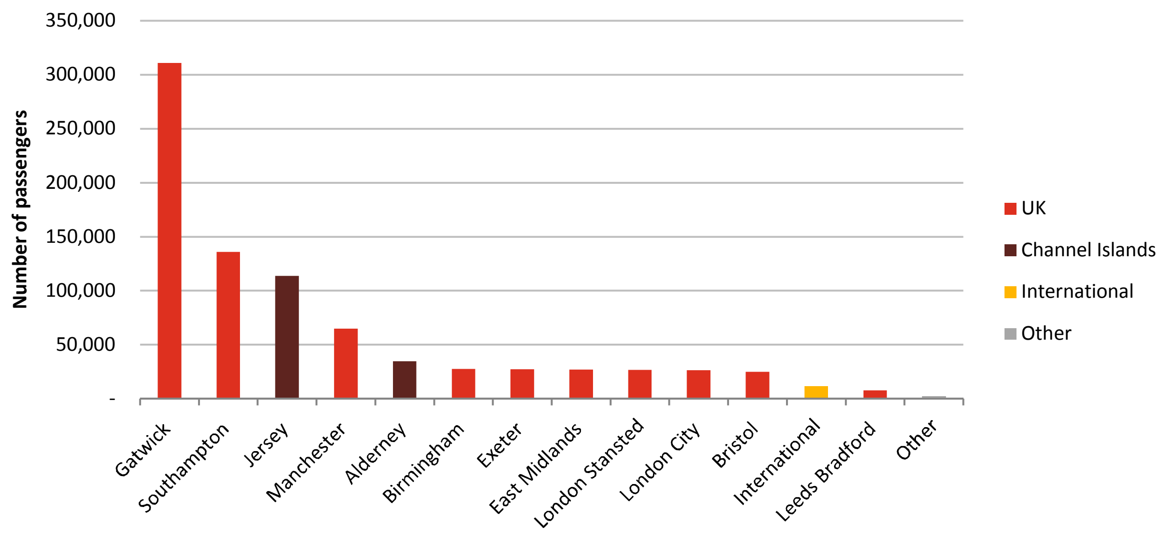
- Avgas is largely used for lighter aircraft;
- Demand for avgas has been slowing over time, with a sharp decline between 2013 and 2014;
- Historically, avgas demand was largely driven by the flight distance of Aurigny's Trislander aircraft, which runs on avgas. However, the Trislander aircraft was due to be retired in 2016;
- We assume that the remaining demand for avgas will be mainly from non-commercial flights;
- Therefore, in all three scenarios, we assume that avgas demand will hold flat at 200 MT.

## 3.4.2 Historical demand trends

*Aircraft routes to Guernsey*

Air passengers to and from the UK made up of 81% of all passengers. The remainder was 18% from inter-island flights and 1% international. Gatwick alone made up a third of all passengers in 2016. This shows that flying to and from Guernsey airport is primarily made up of short-haul flights.

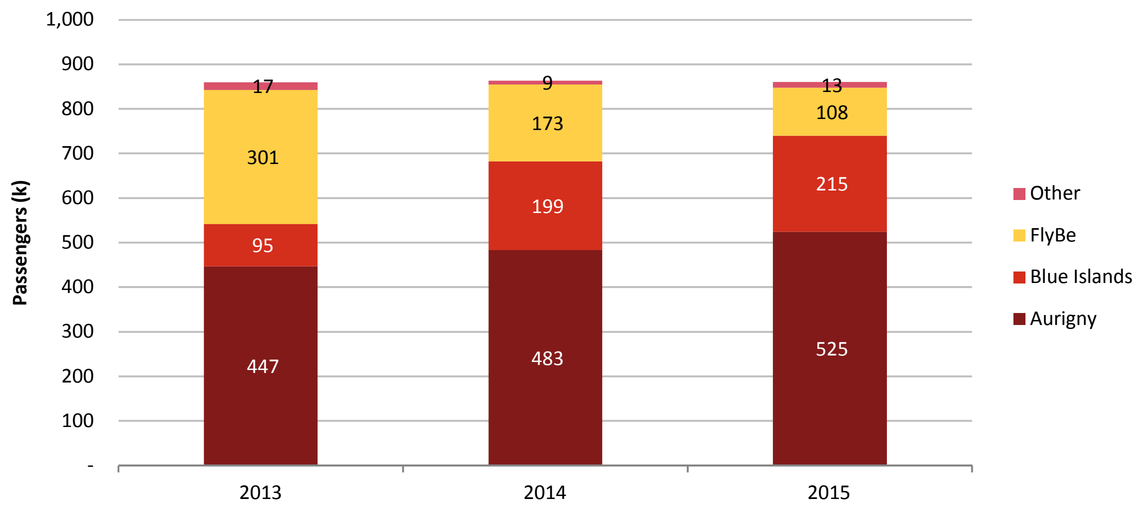
**Figure 3.33: Number of air passengers by route to Guernsey, 2016**




*Source: Guernsey Airport*

In terms of airline market share of passengers, Aurigny Air Services, Guernsey's largest commercial airline, as well as Blue Islands have been steadily gaining share over the 2013-15 period. Aurigny now holds the largest market share of passengers at 61% (an increase from 52% in 2013). Conversely, Flybe has been losing share largely as a result of withdrawing its London-Gatwick routes and scaling back its Southampton schedule.

**Figure 3.34: Number of air passengers in Guernsey by airline, 2013-15**




*Source: Guernsey Airport*

## *Jet fuel*

The price of fuel at larger airports, such as Gatwick, Manchester and Southampton is much cheaper than on Guernsey, mainly due to the UK's highly competitive downstream market with six refineries, the ability to import in bulk from international markets and the ability to move product through an established pipeline system. By contrast, in Guernsey, all fuel is imported by sea in relatively small volumes, which makes prices relatively expensive compared to the UK.

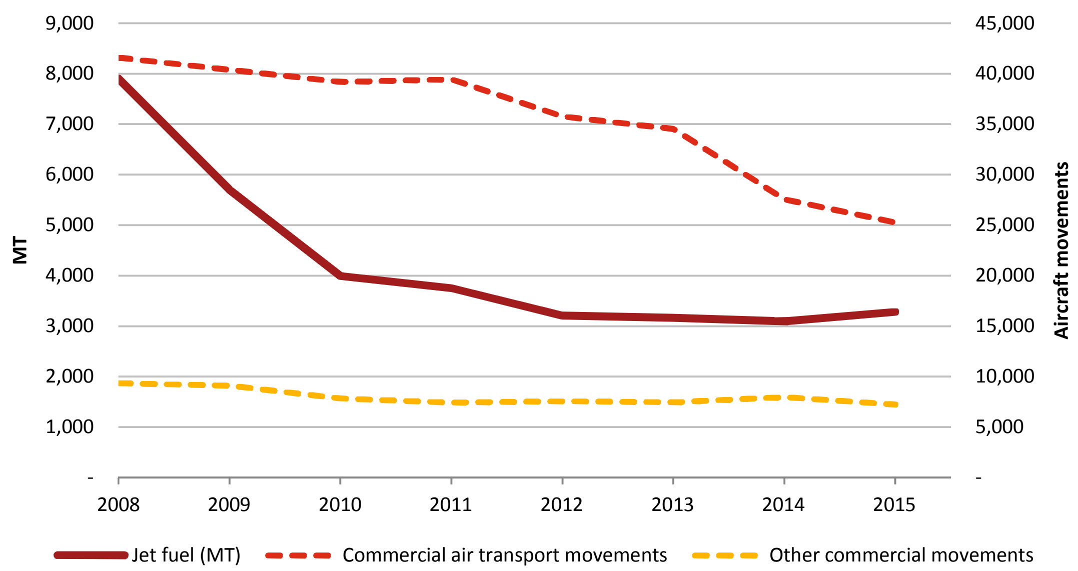
Aurigny state that they only refuel on Guernsey where they have to – for example if an inbound flight had to fly on station until bad weather cleared and therefore used more fuel than expected.

We understand that the difference in fuel prices between Gatwick and Guernsey is c.10p/litre. Aurigny suggested that the difference needs to be closer to 2-3p/litre for them to consider fuelling more regularly in Guernsey.

We have compared the number of aircraft movements in Guernsey with jet fuel demand. Aircraft movements are defined by the Civil Aviation Authority (CAA) as an aircraft take-off or landing that an aircraft makes at an airport. For airport traffic purposes one arrival and one departure are counted as two movements. An aircraft landing at Guernsey airport is the only opportunity a plane would have to refuel in Guernsey.

The figure below shows the change in jet fuel imports and aircraft movements in Guernsey over time.

**Figure 3.35: Jet fuel imports and commercial aircraft movements, 2008-15**




*Source: Guernsey Customs & Excise, Civil Aviation Authority*

Air transport movements relate to aircraft movements engaged on the transport of passengers, cargo, or mail for commercial purposes. Other commercial movements include empty positioning movements, air taxi movements and local movements (commercial flights for press, survey, agricultural and fisheries flying or public entertainment purposes).

In the above figure, we observe that jet fuel imports show a steep decline 2008-11, then flatten out. Aviation fuel in Guernsey was supplied by Shell prior to 2008. According to CICRA's 2014 "*Review of the aviation fuel markets in Jersey and Guernsey*", Shell offered its larger commercial customers a common pricing approach across a range of aviation fuel supply locations. Therefore, smaller, regional airports such as Guernsey airport were able to sell aviation fuel at cheaper prices than the UK and France after VAT and duty refunds. This arrangement removed, or at least substantially reduced, the incentives for large purchasers to take the majority of fuel at larger airports.

Since RUBiS acquired the Shell business in the Channel Islands in 2008, aviation fuel supply operations were no longer part of a large regional network. Therefore, prices of aviation fuel increased in the region, relative to UK and European airports. This increase in prices likely to have driven the steep declines in demand for jet fuel in 2009 and 2010.

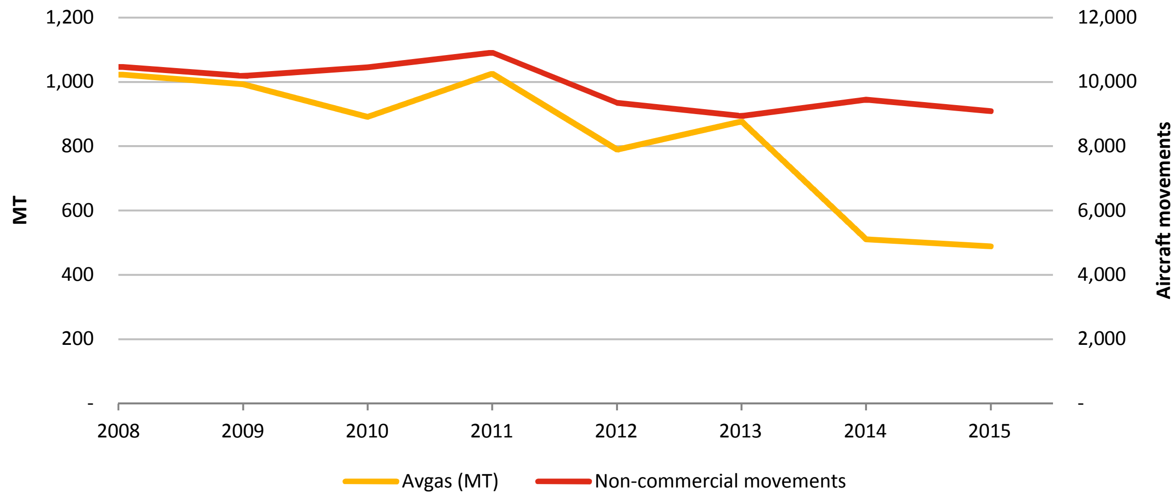
The above figure shows other commercial aircraft movements to be fairly constant over time, while commercial air transport movements have decreased.

In 2014, Aurigny introduced its Embraer jet plane, the largest of its aircraft fleet. This increase in passenger capacity may have contributed to the drop in air transport movements between 2013 and 2014. Flybe also withdrew its five daily rotations to and from London Gatwick and scaled back its Southampton operation from four to only one rotation per day. In addition, a codeshare arrangement between Blue Islands and Aurigny was finalised, resulting in the Trislander fleet being replaced by larger ATR42 aircraft on the Jersey-Guernsey route network.

According to Guernsey Airport, aircraft movements decreased between 2014 and 2015 as a result of schedule changes as fewer, fuller and larger aircraft operated on London Gatwick, Southampton and Jersey air routes.

### *Avgas*

**Figure 3.36: Avgas imports and non-commercial aircraft movements, 2008-15**

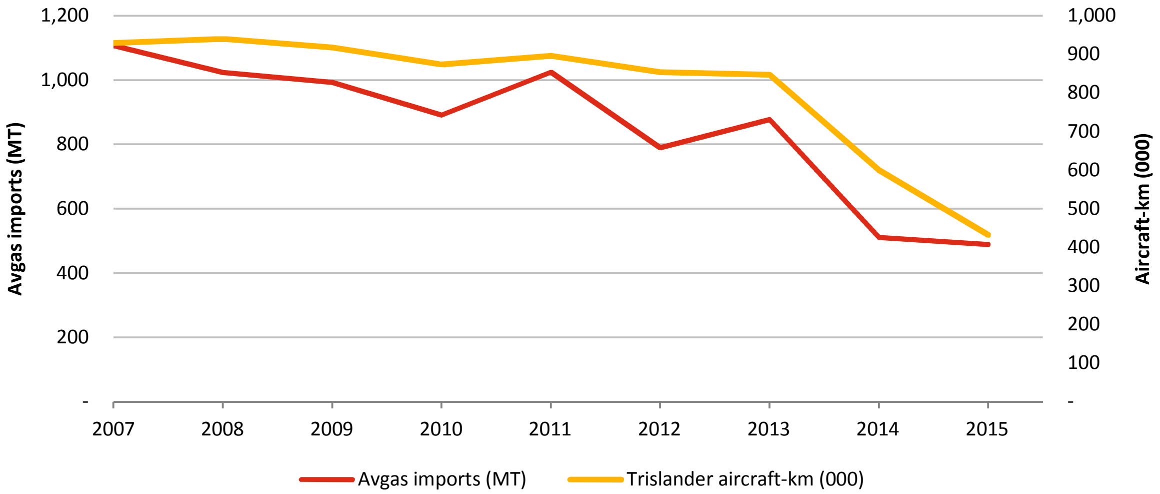



*Source: Guernsey Customs & Excise, Civil Aviation Authority*

The above figure shows non-commercial aircraft movements decreasing gradually over time. Non-commercial movements are largely made up of instructional, recreational and private flights. Avgas imports have also been slowing over time, with a sharp decline between 2013 and 2014.

Using CAA data, we investigated the aircraft-km (number of flights multiplied by flight distance) of Aurigny's Pilatus Trislander aircraft, which runs on avgas fuel. In the figure below, we can see that avgas imports largely track the aircraft-km of the Trislander aircraft.  This is confirmed in CICRA's "*Review of the aviation markets in Jersey and Guernsey*" published in 2014. The drop in Avgas fuel imports form 2013 is therefore substantially due to the Trislander being progressively taken out of service.

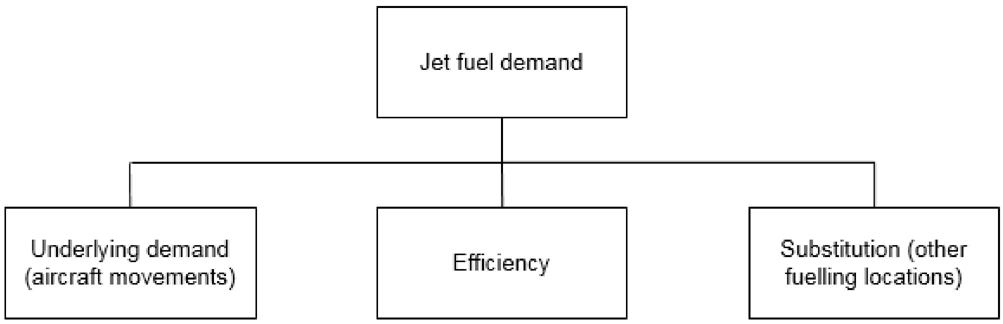
**Figure 3.37: Trislander aircraft-km and Guernsey Avgas imports, 2007-15**




*Source: Guernsey Customs & Excise, Civil Aviation Authority*

## 3.4.3 Forecast methodology and assumptions

*Jet Fuel*

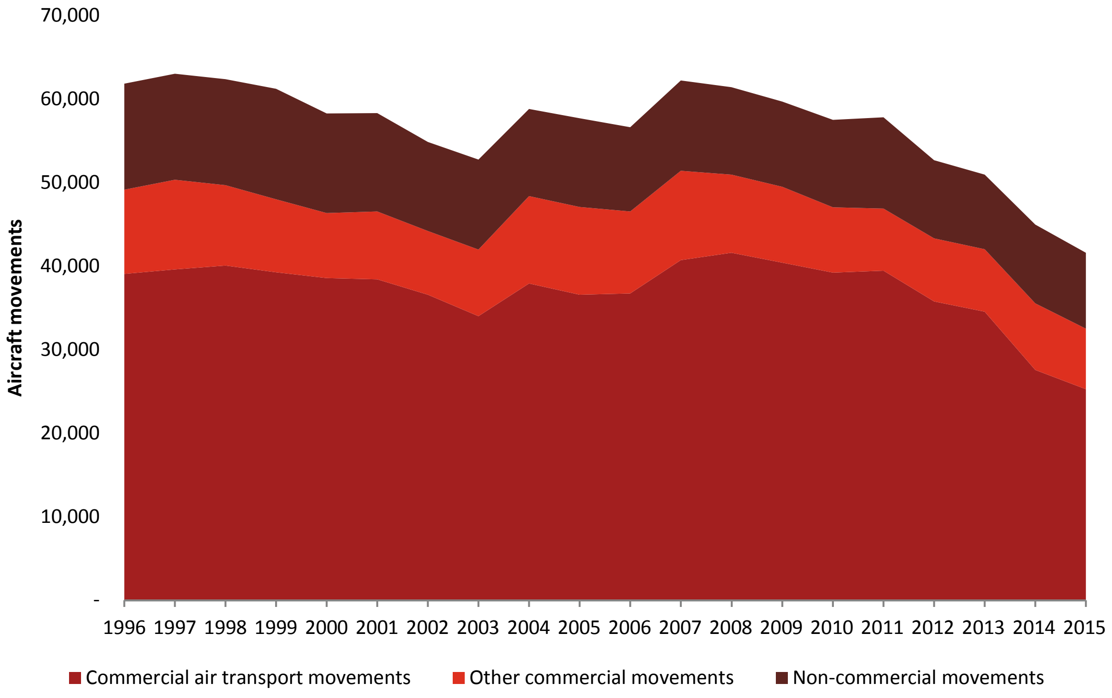



Underlying demand includes the number of aircraft movements in Guernsey and the average import of jet fuel per aircraft movement. We have taken average efficiency improvements from the UK Department for Transport. Substitution in this segments means the relative attractiveness of Guernsey as a fuelling location compared to other served airports.

*Aircraft movements*

As discussed in the 'Historical Demand' section, the number of aircraft movements has decreased over time, largely driven by a reduction in commercial air transport movements.

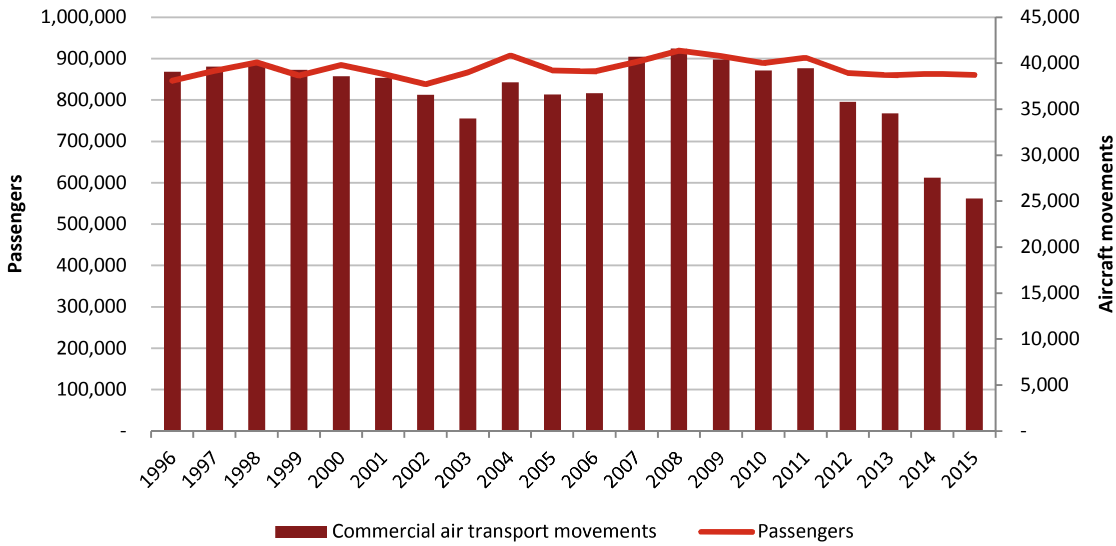
**Figure 3.38: Guernsey airport aircraft movements, 1996-2015**




*Source: Civil Aviation Authority*

Overall aircraft movements have declined by 35% over the 1996-2015 period largely driven by a decrease in commercial air transport movements. However, the number of passengers travelling has stayed broadly constant, implying that the average number of passengers per flight has increased.

**Figure 3.39: Number of commercial air transport movements and passengers at Guernsey airport, 1996-2015**




*Source: Civil Aviation Authority*

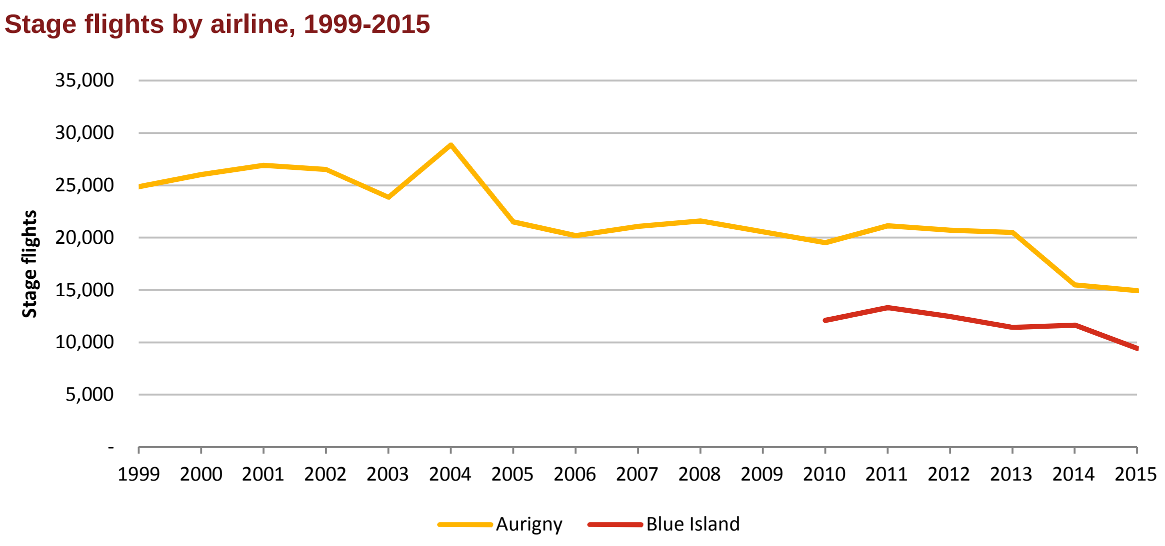
As discussed in the 'Historical Demand' section, this increase in the average number of passengers per flight is due to airlines operating fewer, larger and fuller aircraft on London Gatwick, Southampton and Jersey air routes.

Furthermore, we also did not find strong relationships between GDP, population, median earnings and the number of aircraft movements in Guernsey. The primary determinant of the number of aircraft movements in Guernsey is airline schedules. According to accounts from interviews with Aurigny, Guernsey has an inelastic flight travel market. Aurigny do not have plans to significantly change flight schedules in the foreseeable future, with the exception of potentially shifting routes to Heathrow.

In addition, the flight travel market in Guernsey is fairly stable with relatively few new entrants. According to Guernsey Airport, Easyjet sought to operate a Guernsey-Gatwick route in 2013, but discussions broke down when issues arose relating to Route Transport Licences and charges.

Assuming that all of Aurigny Air Services flights involve flying in or out of Guernsey, Aurigny flights as a percentage of all aircraft movements at Guernsey airport ranged from 35% to 51% between 1999 and 2015. Commercial flights overall made up between 63% and 71% of total aircraft movements.

**Figure 3.40: Number of stage flights by airline, 1999-2015**



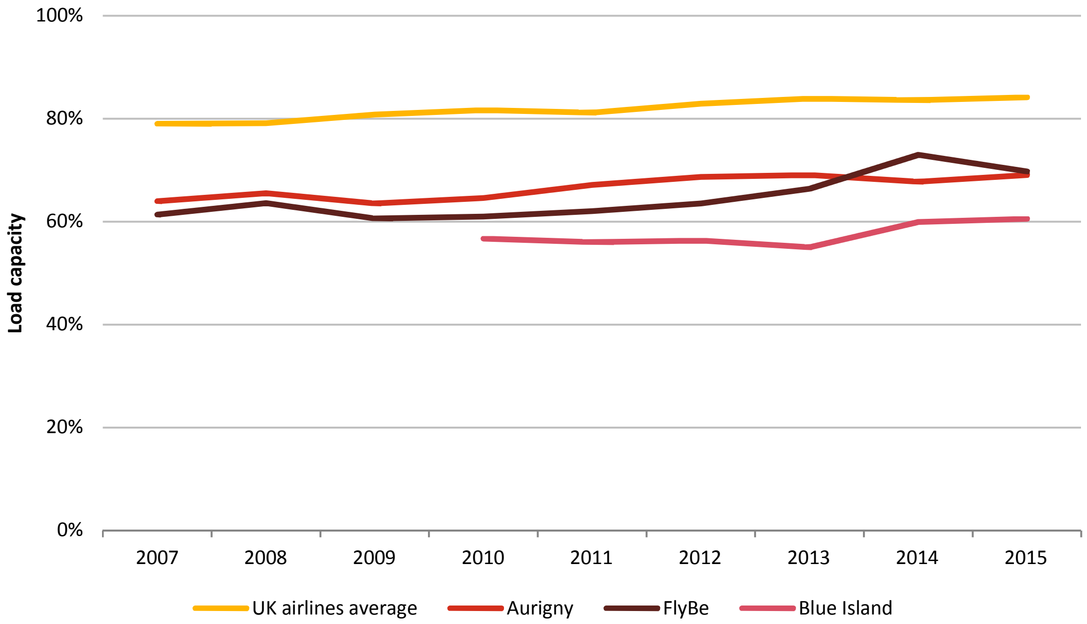

*The figures above include all flights (not limited to Guernsey inbound or outbound flights).

However, flights stops made by smaller aircraft for non-commercial purposes such as recreational and private flights make up a smaller percentage (between 17-21%) of all aircraft movements over the same time period. Therefore, in determining the number of aircraft movements in the future, we mainly consider commercial aircraft movements made by airlines serving Guernsey.

In order to determine if a potential increase in demand for air travel could be served by existing flight schedules, we investigated the historical passenger capacity used (seat-km used as a percentage of seat-km available) by UK airlines.

Guernsey airport is only served by Aurigny Air Services, Flybe and Blue Island. Between 2007 and 2015, the passenger load capacity used of these three airlines varied between 55% and 73%. These levels are below the 79% and 84% range of the average British airline, suggesting that Aurigny, Flybe and Blue Island flights are under-utilised vs. the average UK airline.

**Figure 3.41: UK airlines passenger load capacity used*, 2007-15**




*Source: Civil Aviation Authority*

*The figures above include all flights (not limited to Guernsey inbound or outbound flights). Flybe has a large percentage of non-Guernsey flights. However, the majority of Aurigny flights are to and from Guernsey.

Aurigny would need to improve its passenger load efficiency by c.15 percentage points in order to reach the UK average and therefore is likely able to accommodate an increase in passenger numbers.

The maximum population number at any point in the State of Guernsey's population 2017-2050 central forecasts (which assumes net migration of 150 per year) is only 6% higher than 2015 levels. This suggests that a potential increase in demand for air travel as a result of a growing population in Guernsey could arguably be served by the existing flight schedules of Aurigny, Flybe and Blue Islands without the need for increasing capacity. We therefore assume the number of aircraft movements in Guernsey will remain constant at 39,995 in our base case scenario. This figure is from 2015 as it is the most recent complete year figure of aircraft movements in Guernsey. Annual 2016 data was only partially available at the time of writing.

However, we note that the States of Guernsey Committee for Economic Development has set a target of increasing tourist numbers by around 80,000 up to 2025. According to Guernsey Airport's 2016 business plan, 60% of the additional tourist numbers will arrive by air. As a result, we assume that the number of flights will increase by 15% between 2016 and 2025 (CAGR 1.4% p.a.).

In our low scenario, we assume the passenger load efficiency of Guernsey's three main airlines – Aurigny, Flybe and Blue Island, will achieve the same passenger load efficiency as the average UK airline in 2015 (84%) by 2025. In order to achieve this, we assume the total available seat-km will decrease through a reduction in the number of scheduled flights by 17% between 2016 and 2025.

*Efficiency*

The table below shows the annual average fuel efficiency improvements that underpin the jet fuel consumption forecasts. It is based on the Department for Transport's UK aviation forecasts published in January 2013. The DfT's forecasts assume an introduction of new aircraft across UK based aviation activity will contribute to lower aviation emissions.

The preferred metric for measuring aviation fuel efficiency is seat-kilometres per tonne or kg of fuel. It is a measure of the size and capacity of the plane, distance travelled and amount of fuel burnt.

In the 2011 "*Aviation Marginal Abatement Cost Curve Model study*", the DfT studied how carbon emission savings could be reduced through a variety of policy levers, including regulatory $CO_2$ requirements, air transport movement efficiency, airport capacity, operational incentives and the mandatory use of biofuels. The report assessed the marginal abatement cost (MAC) curves of these policies i.e. how much carbon emissions could be reduced at what cost.

In 2013, the DfT used these cost curves to estimate fuel efficiency savings for a range of scenarios in the *UK Aviation Forecasts* report. The scenarios used were based on low, central and high air passenger demand.

The lower bound of the forecast range (Low demand case) combines high market maturity, low GDP/productivity, low oil prices, low carbon prices, and high fuel efficiency. The upper bound of the forecast range (High demand case) combines low market maturity, high GDP/productivity, high oil prices, high carbon prices and low fuel efficiency.

In the high demand case, efficiency gains are lower than in the central and low demand cases. This is because the high demand case assumes an increase in flight distance, whereas the low demand case assumes a reduction in actual distance flown. These assumptions reflect the advice of independent experts working on the DfT marginal abatement cost curve study analysis in 2011.

Under central demand forecasts, the average fleet fuel efficiency improves by 0.9% p.a. between 2020 and 2030, with efficiency gains accelerating in the future as the current fleet is largely replaced.

**DfT annual average fuel efficiency improvements to 2050**

| | Annual average | | |
|---|---|---|---|
| | DfT passenger demand range forecasts 2008 | | |
| | Central | High | Low |
| 2010-2020* | -0.1% p.a. | -0.3% p.a. | 0.0% p.a. |
| 2020-2030 | 0.9% p.a. | 0.7% p.a. | 0.8% p.a. |
| 2030-2040 | 1.0% p.a. | 0.7% p.a. | 1.4% p.a. |
| 2040-2050 | 1.8% p.a. | 1.5% p.a. | 2.3% p.a. |

*Source: UK Aviation Forecasts, January 2013, Department for Transport*

*While the above table presents a gradual worsening of fuel efficiency between 2010 and 2020 under the central and high forecasts, the DfT has commented that this may understate efficiency gains due to simplifications in its airport allocation model.

In interviews, Aurigny Air Services management stated no current plans to upgrade their Embraer jet plane in the next 5-10 years and their smaller Dornier aircraft in the next 2-3. Due to the lower utilisation of Aurigny's smaller Dornier planes (0.4 hours of average daily utilisation vs. the Embraer jet plane's 7.0 in 2015), the impact of efficiency gains from the replacement of Dornier planes are likely to be relatively small. Therefore, in our base forecast scenario, we assume that jet fuel consumed per flight will remain flat at a 0.0% p.a. improvement until 2026.

After Aurigny aircraft are upgraded, we expect there to be a step-change improvement in fuel efficiency trends as efficiency gains are realised. This improvement could be up to 10% for a new jet plane, according to Aurigny. However, because Aurigny flights to and from Guernsey are relatively short, we may not see the full extent of efficiency gains. Additionally, we cannot determine how jet fuel demand relates to the type of planes that stop to refuel in Guernsey e.g. by aircraft size, route, airline, etc. Therefore, we default to the central demand scenario for fuel efficiency in *UK Aviation Forecasts*.

In our high scenario, we assume jet fuel efficiency will follow the trends of the high demand case in *UK Aviation Forecasts*, which assumes a high productivity/GDP market environment with lower fuel efficiency and high oil prices.

In our low scenario, jet fuel efficiency follows the same trends as the DfT's central demand forecasts throughout the entire forecast period. This implies the assumption that airlines serving Guernsey will upgrade their existing aircraft fleets and retire their more fuel inefficient aircraft at a quicker or same rate as the UK.

**Annual average fuel efficiency improvements assumptions to 2050**

| | **Annual average** | | |
|---|---|---|---|
| | **Base** | **High** | **Low** |
| 2017-2020 | 0.0% p.a. | 0.0% p.a. | 0.0% p.a. |
| 2021-2026 | 0.0% p.a. | 0.7% p.a. | 0.9% p.a. |
| 2027-2030 | 0.0% p.a. | 0.7% p.a. | 0.9% p.a. |
| 2031-2040 | 1.0% p.a. | 0.7% p.a. | 1.0% p.a. |
| 2041-2050 | 1.8% p.a. | 1.5% p.a. | 1.8% p.a. |

### *Avgas*

In 2016, avgas made up only 0.5% of total hydrocarbon imports. In addition, it is imported into Guernsey by roll-on, roll-off (ro-ro) vessels and therefore is part of a different supply chain than the rest of Guernsey's hydrocarbon imports. From interviews conducted with RUBiS, avgas demand is at sustainable volumes.

As discussed in the Historical Demand section, avgas demand is largely driven by the aircraft-km travelled by Aurigny's Trislander aircraft. However, there is also some smaller demand for avgas from non-commercial flights on smaller aircraft for purposes such as instruction, recreation and private flights. However, due to limited data on the types, fleet size, utilisation and replacement rate of non-commercial aircraft fleets, we are unable to use a bottom-up approach to avgas forecasts. Therefore, we focus our analysis on Aurigny's commercial air transport flights made by its Trislander aircraft.

According to news reports, the Aurigny Trislander aircraft was due to be retired in 2016 and replaced by Dornier planes, which run on jet fuel.

We performed a regression analysis on aircraft-km travelled by Aurigny's Trislander aircraft and Guernsey's avgas imports, which resulted in an $R^2$ of 0.88. The p-value of the resulting variable was highly significant at 0.0002. The resulting intercept coefficient of our regression analysis was 182 MT. This implies that when the Trislander aircraft is retired, the remaining avgas demand for non-commercial use is c.182 MT a year.

Therefore, we assume that avgas demand will hold flat at 200 MT.

The fuel efficiency improvements from *UK Aviation Forecasts* as used in our jet fuel forecasts do not apply here because they relate to commercial aircraft fleets.

*Substitution (other fuelling locations)*

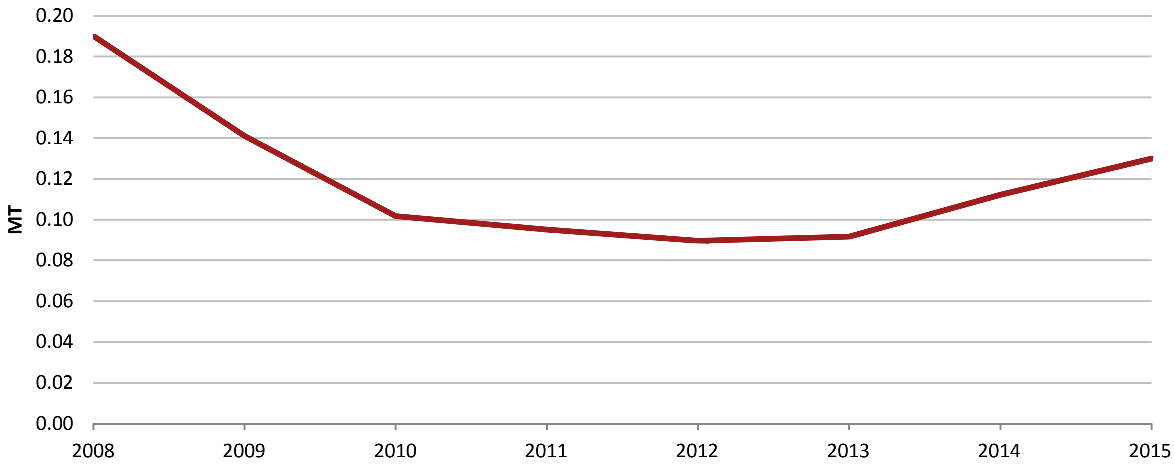
As discussed in the Historical Demand section, since 2008 the price of fuel at other larger airports has been much cheaper than in Guernsey.

We have looked at average fuel imported per commercial air transport movement. After the declines following Shell's exit from the Guernsey market in 2008, it has been relatively constant. This reflects a 'base load' of demand, representing fuel purchases by airlines when they have to 'top up' the aircraft in order to meet regulated standards for fuel reserves for their outbound flights.

Both Aurigny and Guernsey Ports and Airports have stated that without a significant reduction in price, airlines are unlikely to increase the proportion of their fuel that they buy on Guernsey.

Rubis has told us that they have conducted studies and trials to ascertain whether the increasing volumes would allow them to profitably reach the target price needed by the airlines to switch their purchases. The conclusion was that the structural inefficiencies of serving a small island market, compared to a pipeline-fed large mainland airport, would not allow them to achieve this target price.

**Figure 3.42: Jet fuel imported per commercial air transport movement, 2008-15**




*Source: Guernsey Customs & Excise, Civil Aviation Authority*

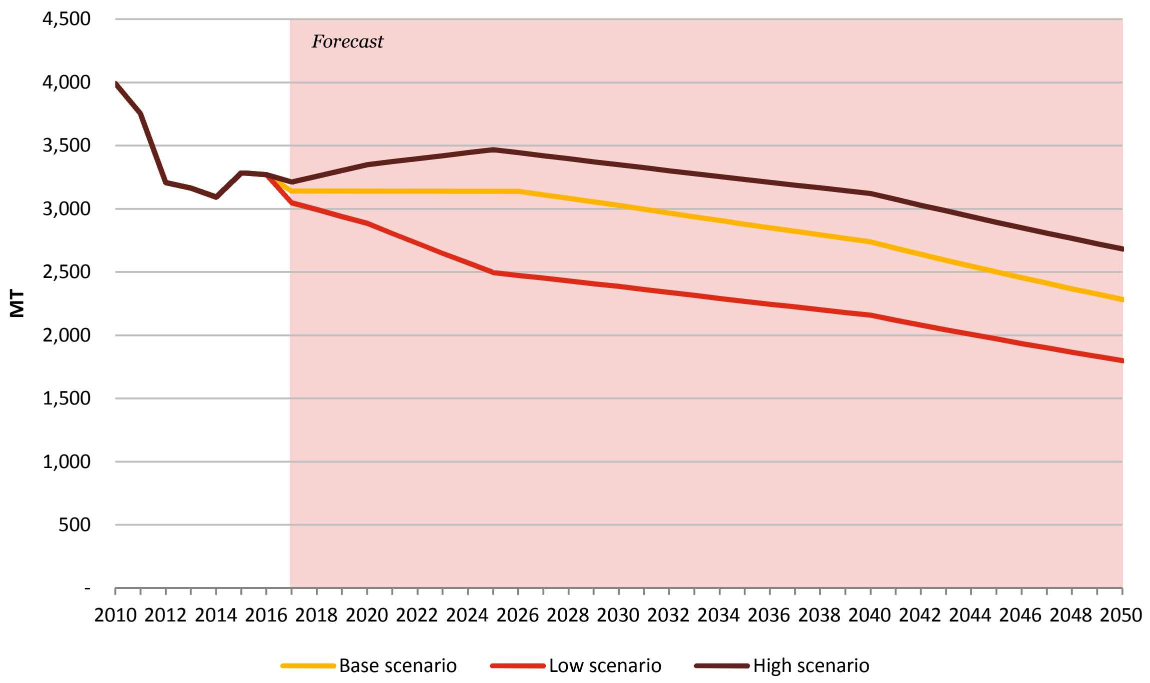
In our forecasts, we have therefore assumed that jet fuel imported per aircraft movement will remain fairly constant at an average of 2014-16 levels.

### 3.4.4 Conclusions

*Jet Fuel*

Forecasted jet fuel demand is summarised below.

**Figure 3.43: Forecast jet fuel consumption, 2017-2050**




| | CAGR | |
|---|---|---|
| | 2010-2016 | 2017-2050 |
| **Base** | -3.8% p.a. | -1.0% p.a. |
| **High** | -3.8% p.a. | -0.5% p.a. |
| **Low** | -3.8% p.a. | -1.6% p.a. |

*Avgas*

Forecasted avgas demand is summarised below.

| | Forecasted avgas demand (MT) |
|---|---|
| 2017 | 200 |
| 2050 | 200 |
| Implied growth % p.a. | 0.0% |
| Total implied growth % | 0.0% |

# 3.5 Marine demand

## 3.5.1 Executive Summary

- We have defined marine fuel demand as the volume of gas oil consumed for shipping, which in Guernsey is primarily small vessels used for recreation, inter island-travel and fishing;
- Although historical data on gas oil imports are available, they have not been split out for marine and heating, therefore we cannot analyse historical trends for marine demand;
- Fishing, recreation and inter-island demand are not expected to be large areas of growth, although recreation and inter-island vessels may demand more marine fuel if the States of Guernsey Committee for Economic Development's tourism targets are met;
- In our base case, we assume that marine fuel demand will remain flat;
- Our low case indicates a drop of 0.5% p.a. in demand to reflect the possibility of a decrease in popularity of recreational boating. Our high case assumes 30% growth to 2025 as per the States of Guernsey Committee for Economic Development's tourism targets and following Guernsey's high population forecasts thereafter. This implies a growth in demand of 0.9% p.a.

## 3.5.2 Historical demand trends

Historical data on gas oil imports are not split out between marine and heating, so we cannot analyse historical trends. From speaking with RUBiS, CI Fuels and the Policy and Resources Committee, we estimate total marine gas oil imports for 2016 to be around 5.1 million litres or 4,274 MT. Guernsey marine gas oil therefore makes up around 20% of all gas oil and road diesel, although this estimate could be subject to error.

According to the Channel Islands Competition and Regulatory Authorities, the majority of the marine fuel market in the Channel Islands is made up of marine gas oil with a very small proportion of marine petrol. We have assumed that marine gas oil makes up the whole of the marine market in Guernsey.

The figure below shows the number of marine vessels in Guernsey by purpose in 2015. Though a large proportion of vessels in Guernsey are used for recreation, commercial vessels such as fishing vessels and ferries have higher utilisation and so have much higher fuel demand per vessel than recreational vessels.

**Number of vessels in Guernsey by purpose, 2015**

| Recreational | Fishing | Inter-island travel |
|---|---|---|
| 4,500 | 166 | 6 |

*Source: Guernsey Harbours, States of Guernsey*

According to representatives from Guernsey Ports, there are 10-12 super yachts that travel through Guernsey per year, which may create some passing trade for marine gas oil. However we do not have data on whether they have refuelled in Guernsey historically or whether they might do so in the future. Therefore we have not considered this as part of our forecast. We have not included any forecasts around whether Guernsey might become a bunkering destination.

### 3.5.3 Forecast methodology and assumptions

Marine gas oil demand can be split into three main use cases – recreation, fishing and inter-island ferry travel. We have not forecast demand for each segment due to a scarcity of data. Instead, we have looked at general trends in the three segments and attached growth values to them according to indicators such as tourism, population change and fishing demand.

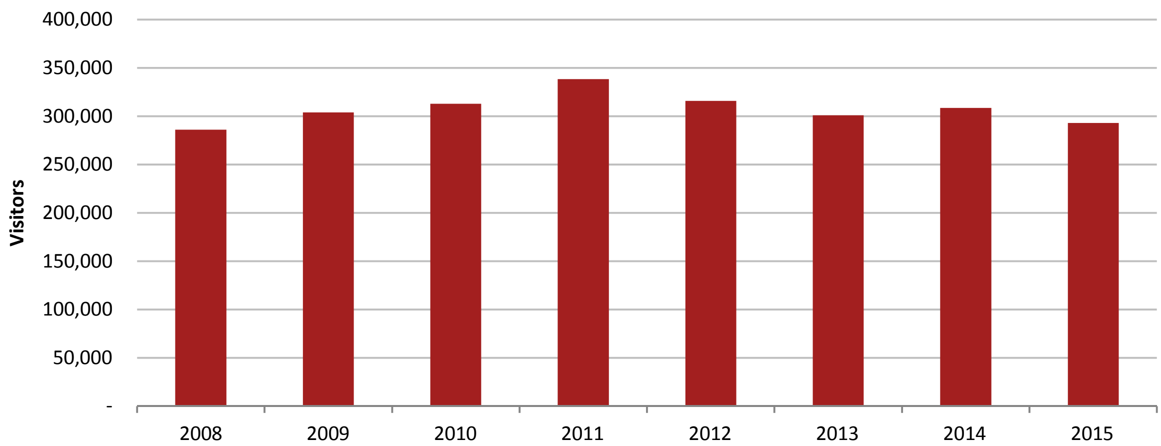
Interviews with industry participants suggest that the marine fuel market in general is not an area of growth and demand is likely to remain fairly constant.

*Recreation*

In 2015, Guernsey had a high percentage of boat ownership (7.2%) when compared to the UK (0.9%). Assuming one boat per household, around 17% of households in Guernsey have access to a boat.

Recreational boating may also be driven by tourist numbers, which have been broadly flat since 2008, apart from a peak in 2011.

**Figure 3.44: Visitors to Guernsey, 2008-15**




*Source: Guernsey Policy & Resources Committee*

| | CAGR |
|---|---|
| **2008-15** | 0.4% p.a. |

According to the Guernsey Marketing and Tourism unit, the high point in 2011 was primarily caused by more direct ferry sailings from France and better inter-island connections.

The fall in visitor numbers between 2011 and 2012 was attributed by the Guernsey Marketing and Tourism unit to a tough trading environment and poor weather.

The States of Guernsey Committee for Economic Development (and the former Commerce and Employment Department) has set a target growth of growing visitor numbers by 30% to reach 400,000 visitors to the island by 2025, for example by securing stronger route connections to Guernsey from the north of England and Europe. This may boost tourist numbers going forward.

Recreational boating can be an expensive hobby. *The Leisure Marine Survey Report, September 2016* suggests that 17% of surveyed boat owners are considering giving up boating as a pastime. More than half of these respondents cited cost as a factor. For an illustrative low case we have shown the impact of a slight decline in recreational boating on cost grounds.

We have therefore created three demand scenarios based on tourism:

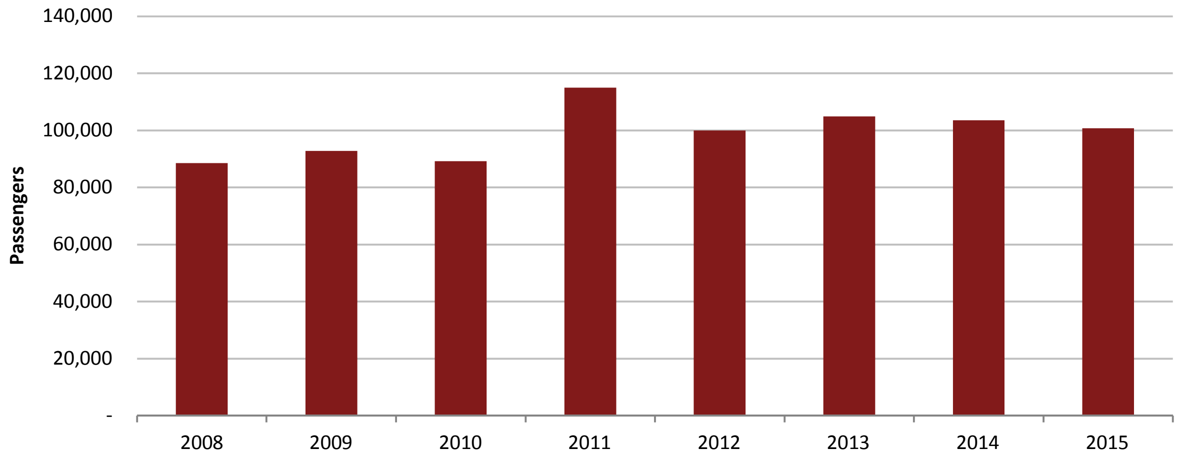
- Base case – we assume that tourism and recreational boating will remain flat over time
- High case – Guernsey's tourism targets form our upper boundary forecasts to 2025, after which growth trends with the State of Guernsey's high case population forecasts
- Low case – A 0.5% p.a. decline to represent a reduction in recreational boating due to cost

### *Inter-island travel*

The number of sea passengers between the islands, which made up on average 32% of total visitors arriving in Guernsey between 2008 and 2015, largely trends with the number of visitors to Guernsey. We therefore expect demand for inter-island travel to trend with recreational demand.

The following figure shows some growth in the number of passengers by sea from the Channel Islands over 2008-15.

**Figure 3.45: Number of inter-island sea passengers, 2003-15**




*Source: Guernsey Policy and Resources Committee*

| | CAGR |
|---|---|
| **2008-15** | 1.9% p.a. |

From interviews with the State of Guernsey and fuel distributors, we understand that there are six commercial vessels used for inter-island travel. Representatives from Guernsey Ports do not expect the vessels used for inter-island commercial travel to change in the near future.

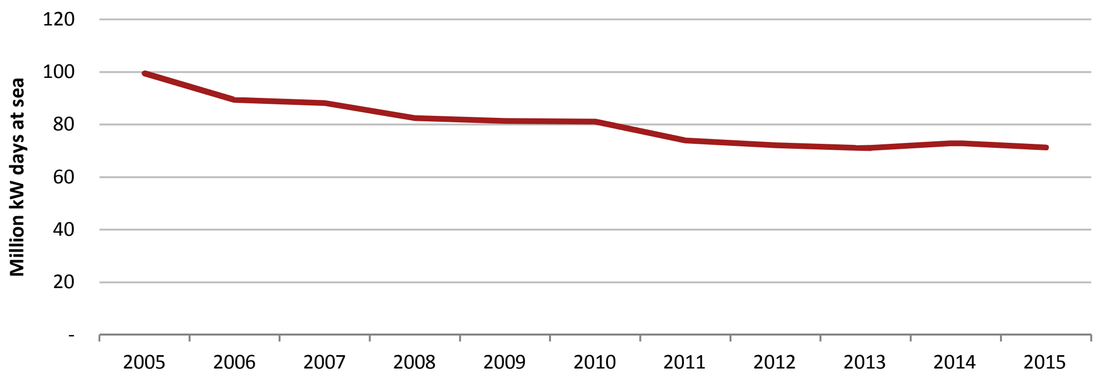
Demand from inter-island vessels for marine gas oil is therefore expected to be flat going forward, which is reflected in our base case. Our high case and low case assume that inter-island travel trends with identical drivers as recreational boating i.e. tourism.

## *Fishing*

As stated, Guernsey's fishing fleet may be small in proportion to total marine vessels but fishing vessels are likely to use more fuel on average due to higher utilisation. Comparisons with the UK may be instructive.

According to the *UK Sea Fisheries Statistics 2015*, since 2005 to 2015, the number of fishermen on UK registered vessels has decreased by 6% and the number of fishing vessels by 8%. This decline in fishermen numbers may be associated with reductions in fleet size as well as decreased fishing opportunities in the UK. The UK fisheries administrations have also operated decommissioning exercises in 2007 and 2008-2009 aimed at withdrawing some capacity and fishing effort from UK fisheries to help ensure sustainable fishing. This means that overall UK fishing fleet effort has also been declining over time, meaning less energy is used by the fleet each year.

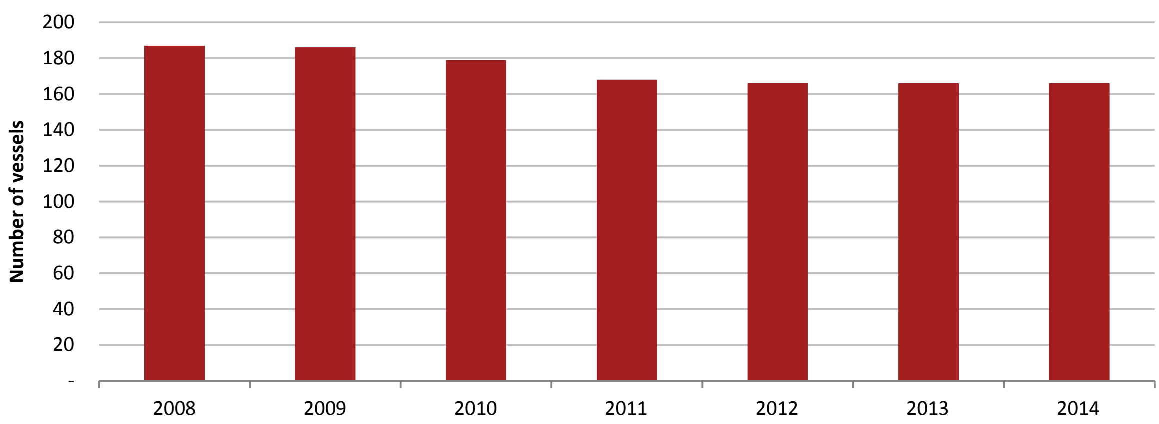
**Figure 3.46: UK fishing fleet effort, 2005-15**




*Source: Marine Management Organisation*

Similarly in Guernsey, the number of licensed fishing vessels has decreased by 11% between 2008 and 2014 (CAGR 2.0% p.a.). The *Guernsey Sea Fisheries Statistics* 2013 report notes that harbour regulations require anyone working on a fishing vessel to complete five safety courses in order to be registered. As a result, a number of smaller, part-time vessels deregistered due to the extra time and expense required.

**Figure 3.47: Number of Guernsey fishing vessels, 2008-14**



*Source: States of Guernsey*

| | CAGR |
|---|---|
| **2008-14** | -2.0% p.a. |

We have not assumed any change in demand for fishing in our base and high cases. However, our low case uses a decline of 0.5% p.a. in marine gas oil demand to represent a continuation of historical declines in fishing vessels.

### 3.5.4 Conclusions

We apply the following growth rates to our forecasts.

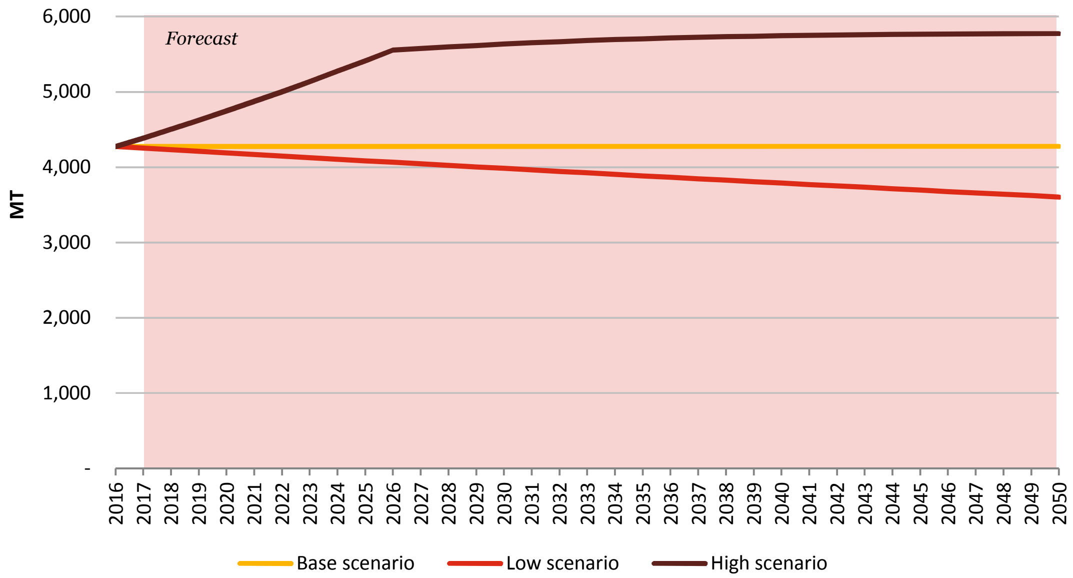
**PwC annual marine fuel demand assumptions to 2050**

| | Annual average % change | | |
|---|---|---|---|
| | **Base** | **High** | **Low** |
| 2017-2050 | No change | 30% over 10 years, then changes at same rate as the Policy and Resources population projection with +200 net migration a year | -0.5% p.a. |

Our forecasts for marine gas oil demand are summarised below.

| | Forecasted marine gas oil demand (MT) | | |
|---|---|---|---|
| | **Base** | **High** | **Low** |
| 2016 | 4,274 | 4,274 | 4,274 |
| 2050 | 4,274 | 5,773 | 3,605 |
| Implied growth % p.a. | 0.0% | 0.9% | -0.5% |
| Total implied growth % | 0.0% | 31.6% | -15.2% |

**Figure 3.48: Marine gas oil demand forecast, 2016-2050**

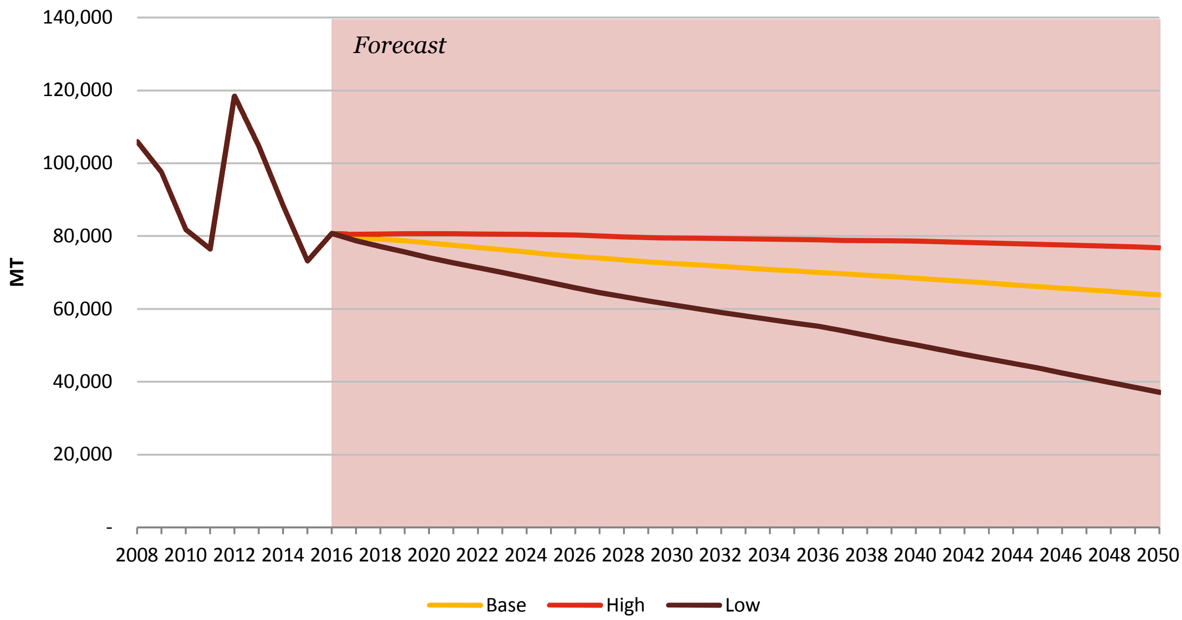


# 3.6 Total hydrocarbon demand

## 3.6.1 Scenario comparison

Aggregating all our forecasts gives the following forecast for total hydrocarbon consumption:

**Figure 3.49: Guernsey hydrocarbon demand by scenario, 2008-2050**




| | Imports (MT) | | | CAGR | |
|---|---|---|---|---|---|
| | 2008 | 2016 | 2050 | 2008-2015 (excl. HFO) | 2016-2050 |
| **Base** | 105,966 | 80,740 | 63,887 | -2.5% p.a. | -0.7% p.a. |
| **High** | 105,966 | 80,740 | 76,817 | -2.5% p.a. | -0.2% p.a. |
| **Low** | 105,966 | 80,740 | 37,102 | -2.5% p.a. | -2.3% p.a. |

*HFO has been removed from the 2008-2016 CAGR equation due to a large degree of volatility.

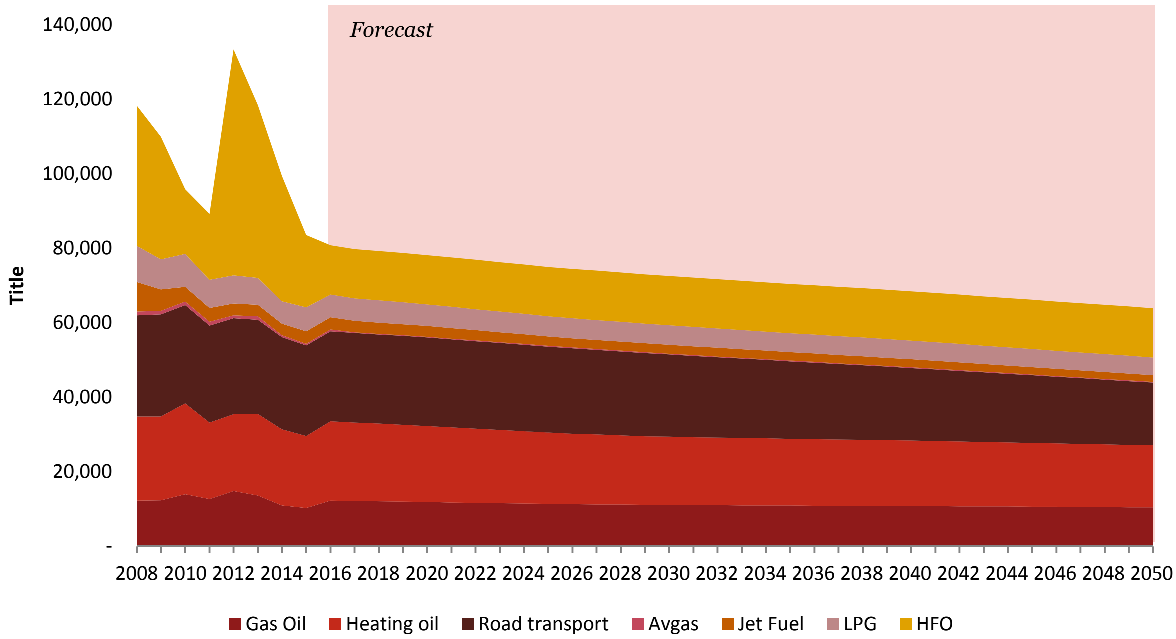
All three scenarios forecast a drop in hydrocarbon demand up to 2050 at a more gradual rate than historical CAGRs 2008-2015. The continued decline is due to a mixture of improving fuel/heating efficiencies and shifts to EVs for road transport.

In all scenarios, HFO demand has been held flat as per GEL's forecast.

# 3.6.2 Scenarios by fuel demand

*Base scenario*

**Figure 3.50: Hydrocarbon demand forecast - base case, 2008-2050**

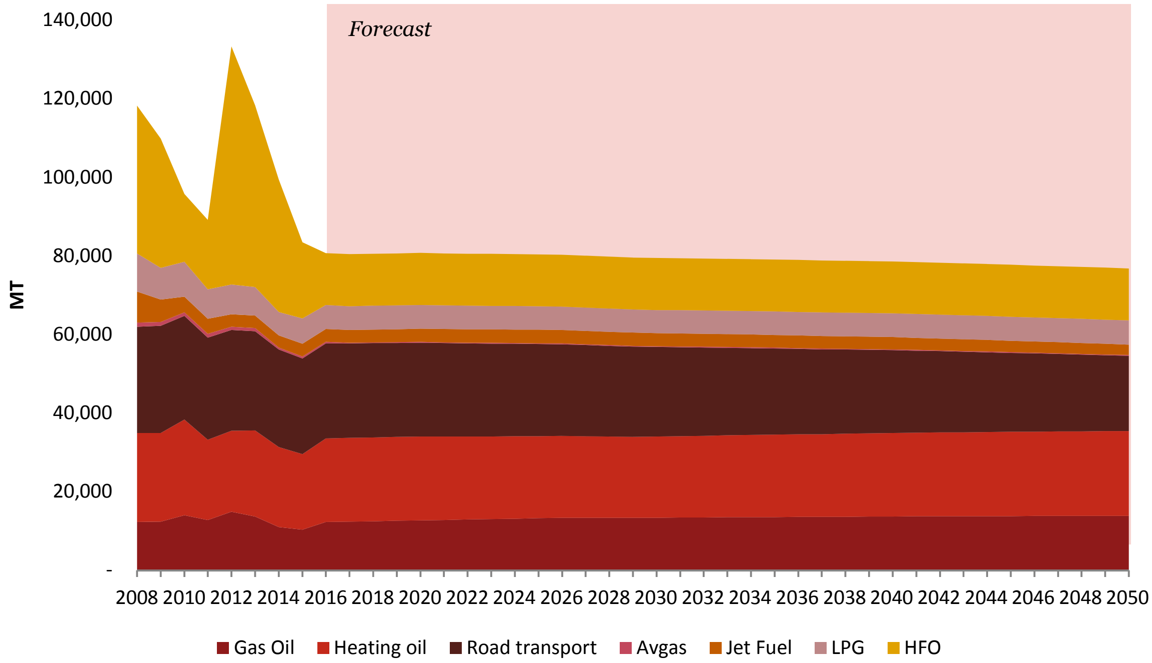



| | CAGRs | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **LPG** | -5.7% p.a. | -0.7% p.a. |
| **Jet fuel** | -10.4% p.a. | -1.6% p.a. |
| **Avgas** | -9.4% p.a. | 0.0% p.a. |
| **Road transport** | -1.4% p.a. | -1.1% p.a. |
| **Heating oil** | -0.7% p.a. | -0.7% p.a. |
| **Gas oil** | 0.0% p.a. | -0.4% p.a. |
| **HFO** | N/A | 0.0% p.a. |
| **TOTAL** | -2.5% p.a. | -0.7% p.a. |

Road transport and jet fuel show the largest declines over the forecast period. This is primarily due to improvements in efficiency. Falls in LPG and heating oil can also be explained by increasing efficiency in residential and commercial heating.

## *High case*

**Figure 3.51: Hydrocarbon demand forecast - high case, 2008-2050**



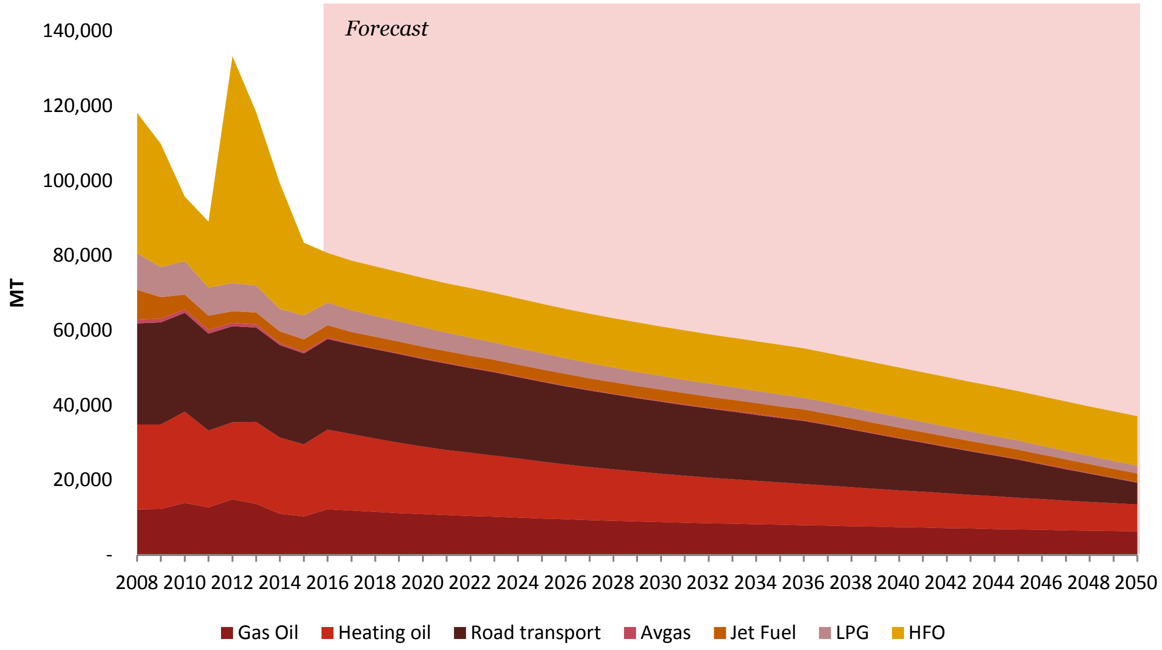

| | CAGRs | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **LPG** | -5.7% p.a. | 0.0% p.a. |
| **Jet fuel** | -10.4% p.a. | -0.5% p.a. |
| **Avgas** | -9.4% p.a. | 0.0% p.a. |
| **Road transport** | -1.4% p.a. | -0.7% p.a. |
| **Heating oil** | -0.7% p.a. | 0.0% p.a. |
| **Gas oil** | 0.0% p.a. | 0.3% p.a. |
| **HFO** | N/A | 0.0% p.a. |
| **TOTAL** | -2.5% p.a. | -0.1% p.a. |

Our high case shows broadly flat demand. Although road transport and jet fuel continue to show the largest declines in demand in our high case, LPG and heating oil demand remains relatively constant due to only a small change in the size of the total heating market.

Gas oil demand grows in this scenario due to an increase in the size of the marine market.

*Low case*

## Figure 3.52: Hydrocarbon demand forecast - low case, 2008-2050




| | CAGRs | |
|---|---|---|
| | **2008-2016** | **2017-2050** |
| **LPG** | -5.7% p.a. | -3.1% p.a. |
| **Jet fuel** | -10.4% p.a. | -1.0% p.a. |
| **Avgas** | -9.4% p.a. | 0.0% p.a. |
| **Road transport** | -1.4% p.a. | -4.2% p.a. |
| **Heating oil** | -0.7% p.a. | -3.1% p.a. |
| **Gas oil** | 0.0% p.a. | -1.9% p.a. |
| **HFO** | N/A | 0.0% p.a. |
| **TOTAL** | -2.5% p.a. | -2.3% p.a. |

In our low case, LPG, heating oil and gas oil show steep declines in favour of electricity in the heating market. A rapid uptake in EVs means road transport demand declines at-4.2% p.a.

## *Toggles*

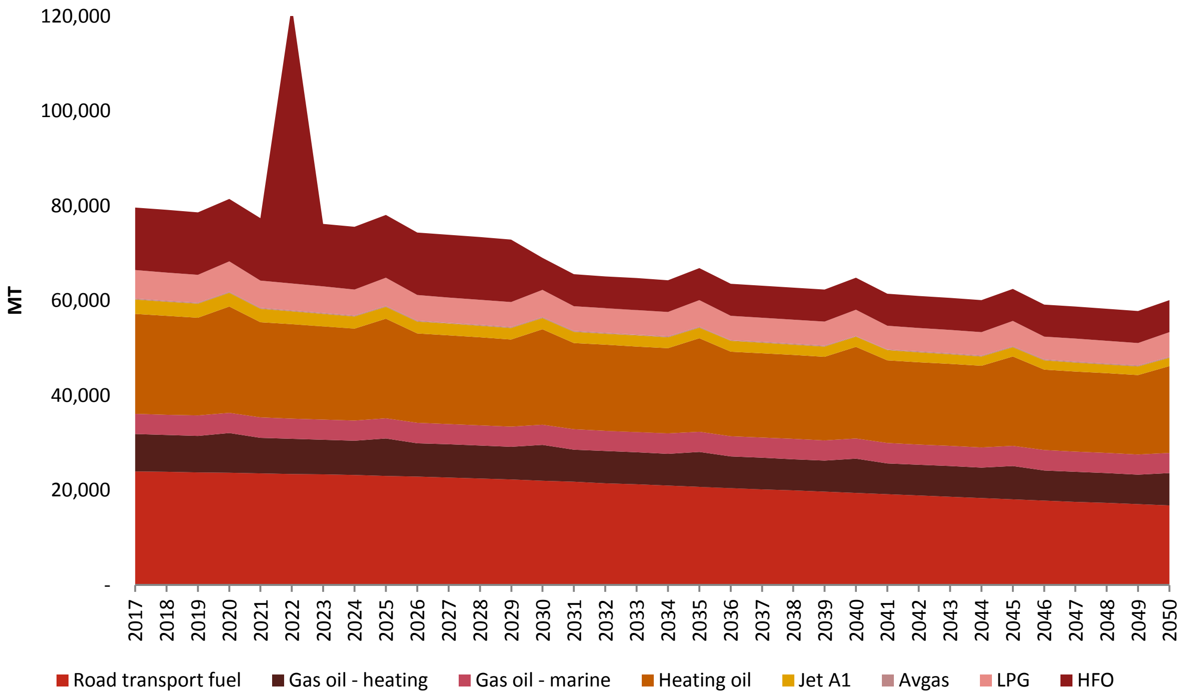
We have used three toggles in our analysis:

1) The effect of a cold winter on heating demand;
2) The effect of the construction of a second interconnector;
3) The effect on HFO consumption if Guernsey's interconnectors failed, meaning 75% of electricity generation had to occur on-island.

In the following example, we have assumed the following using our base scenario:

1) There will be a cold winter every 5 years starting in 2020;
2) A second interconnector is constructed in 2030;
3) Guernsey needs to supply 75% of its electricity via on-island generation in 2022.

**Figure 3.53: Hydrocarbon demand by product, with selected toggles, 2017-2050**



# 4. Appendix

# 4.1 National Grid Scenarios

The National Grid forecasts energy demand in the UK up to 2040 in its Future Energy Scenarios publication. It suggests four scenarios based on the future degree of economic prosperity and focus on implementing environmental policies. These are laid out in the table below.

Increasing prosperity

| "Consumer Power" | "Gone Green" |
|---|---|
| Consumer Power is a market-driven world, with limited government intervention. High levels of prosperity allow for high investment and innovation.<br><br>New technologies are prevalent and focus on the desires of consumers over and above reducing greenhouse gas emissions. | Gone Green is a world where policy interventions and innovation are both ambitious and effective in reducing greenhouse gas emissions.<br><br>The focus on long-term environmental goals, high levels of prosperity and advanced European harmonisation ensure that the 2050 carbon reduction target is achieved. |
| **"No Progression"** | **"Slow Progression"** |
| No Progression is a world where business as usual activities prevail.<br><br>Society is focused on the short term, concentrating on affordability above green ambition. Traditional sources of gas and electricity continue to dominate, with little innovation altering how energy is used. | Slow Progression is a world where economic conditions limit society's ability to transition as quickly as desired to a renewable, low carbon world.<br><br>Choices for residential consumers and businesses are restricted, yet a range of new technologies and policies develop. This results in some progress towards decarbonisation but at a slower pace than society would like. |

Greater environmental concern

*Source: National Grid*

Specifically, we have used the following National Grid projections in our forecasts:

- Residential heating demand supplied by gas;
- Residential heating demand supplied by electricity;
- Commercial energy demand;
- Residential lights and appliances demand;
- Electricity demand from EVs;
- Uptake of EVs;
- Uptake of heating technologies.

## 4.2 Glossary

| Fuel | Gross GJ per tonne | Density conversion ($M^3$ to MT) | Markets |
|---|---|---|---|
| Petrol | 49.3 | 0.740 | Road transport |
| Diesel / gas oil | 45.7 | 0.839 | Road transport, heating, marine |
| Aviation gasoline | 47.4 | 0.725 | Aviation |
| Heating oil / kerosene | 46.2 | 0.806 | Heating |
| Jet fuel | 46.2 | 0.806 | Aviation |
| Heavy fuel oil | 43.4 | 0.939 | Electricity generation |
| LPG | 49.3 | 0.542 | Heating |

| | |
|---|---|
| Aircraft movements | An aircraft take-off or landing that an aircraft makes at an airport. One arrival and one departure are counted as two movements. |
| CAA | Civil Aviation Authority, the UK's specialist aviation regulator |
| CAGR | Compounded annual growth rate between a starting point to an end point, without consideration of changes between those points |
| Calorific value | Measure of the energy content of a gas or a liquid |
| CHP | Combined Heat and Power units, using heat engines and power stations to generate electricity and useful heat |
| DfT | Department for Transport |
| EIA | Energy Information Administration, a statistical and analytical agency within the U.S. Department of Energy providing independent energy information to inform policymaking |
| EV | Electric Vehicle, which uses one or more electric motors for propulsion |
| Full insulation | According to the UK government, a household has 'full insulation' if it has at least 100mm of loft insulation (where there is a loft), cavity wall insulation (where there is a cavity) and at least 80% of rooms with double-glazing. |
| GEL | Guernsey Electricity Limited |
| GJ | Gigajoule, a unit of energy equivalent to one billion joules. |
| GWh | Gigawatt-hour, a unit of energy representing one billion watt hours, or 1,000 megawatts of electricity used continuously for one hour |
| HFO | Heavy fuel oil |
| ICOMIA | International Council of Marine Industry Associations, an international trade association representing the global marine industry |

| | |
|---|---|
| IEA | International Energy Agency, an autonomous organisation working to ensure reliable, affordable and clean energy for its 29 member countries and beyond |
| Ktoe | Unit of energy defined as the amount of energy released by burning one thousand tonnes of oil equivalent. |
| LED | Light-Emitting Diode, a semiconductor diode which glows when electricity passes through it. These are typically more efficient than traditional light sources. |
| MACC | Marginal Abatement Cost Curve, a model-derived curve which shows the marginal cost of additional reductions in pollution |
| MOT | Ministry of Transport tests, a compulsory annual test for safety and exhaust emissions of motor vehicles of more than a specified age |
| MT | Metric tonne, an SI unit of weight equivalent to 1,000 kilograms |
| MWh | Megawatt-hour, a unit of energy representing one million watt hours, or 1,000 kilowatts of electricity used continuously for one hour |
| N-2 policy | Policy stating that if Guernsey's two largest supplies of electricity are disrupted, the island is still able to meet electricity demand |
| OECD | The Organisation for Economic Co-operation and Development, an intergovernmental organisation with a 35 member countries committed to stimulating economic progress and world trade |
| P.a. | Per annum |
| Passenger -miles | One mile travelled by one passenger, as a unit of traffic |
| Ppl | Pence per litre |
| $R^2$ | A measure of how well two variables correlate with each other |
| Ro-ro vessels | Roll-on/roll-off vessels are ships designed to carry wheeled cargo, such as cars, trucks, trailers, etc. that are driven on and off the ship on their own wheels are using a platform vehicle |
| Seat-kilometres | A measure of an aircraft's carrying capacity equal to the number of seats multiplied by the number of kilometres flown by the aircraft |
| VAT | Value-added tax, a general consumption tax on goods and services |
| Vehicle-miles | One mile travelled by one vehicle, as a unit of traffic |
| Vehicle parc | The total number of vehicles in a specified region |

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