



Institute for Sustainability



SEStran Report: *Seafari* (Maid of the Forth) North Berwick Fuel Trials



This document is part of iTransfer, a North Sea Region Interreg programme project, which is funded by the European Regional Development Fund.

iTransfer (Innovative Transport Solutions for Fjords, Estuaries and Rivers) aims to make ferry transport more freely accessible and sustainable, and encourage more people to travel by water. In areas in the North Sea Region (NSR) there are opportunities to replace existing vehicle routes with passenger ferries as a viable alternative. Travelling by ferry is more sustainable, easier and quicker. It can also provide lifeline services to remote communities.

For more information visit www.itransferproject.eu

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Introduction

iTransfer (Innovative Transport Solutions for Fjords, Estuaries and Rivers) aims to make ferry transport more freely accessible and sustainable, and encourage more people to travel by water. In areas in the North Sea Region (NSR) there are opportunities to replace existing vehicle routes with passenger ferries as a viable alternative. Travelling by ferry is more sustainable, easier and quicker. It can also provide lifeline services to remote communities.

iTransfer is an inter-regional (Interreg) initiative that is an EU part-funded programme that encourages Europe's regions to form partnerships and work together on common projects. The main objective of iTransfer is to develop and present innovative, sustainable solutions in ferry technology, operation and policy to improve regional accessibility by water-based transport in the North Sea Region.

Background/challenge

Maid of the Forth started as a small local ferry operator based in the Firth of Forth, the main base being at South Queensferry almost underneath the world famous Forth Rail Bridge. The company operates a 225 passenger ferry servicing the island of Inchcolm known as the 'Iona of the East' because of its medieval abbey. It also developed wildlife tours from this site using a 12 passenger RIB to the local wildlife hotspots within the estuary. A highlight of these tours is the sighting of Puffins only a few miles off Edinburgh City shoreline.

Five years ago the company expanded into North Berwick in East Lothian about 20 miles east of Edinburgh and bought two new 12 passenger RIBS to offer wildlife cruises mainly to the world famous Bass Rock. This has the largest single rock colony of Northern Gannets in the world with over 160,000 birds which visitors describe as awesome. Two years ago the company carried Sir David Attenborough out to the rock to do some filming and when asked he described the Bass Rock and its gannets as "One of the wildlife wonders of the world" The RIBS have been a great success operating from April of the end of October.

Two years ago the company were awarded a licence from Scottish Natural Heritage to run landing trips out to their National Nature Reserve on the Isle of May and this also has proven to be a great success. The main attractions there are over 40,000 Puffins and a large colony of Grey Seals.



Choice of vessel

The decision was taken in 2011 to commission the building of a custom designed new vessel to satisfy the increasing demand for boat trips from North Berwick. Considerable research went into the choice and design of the vessel to comply with the requirements of the trips and the restrictions imposed by the confines of the small harbour. The maximum length allowed to berth in the harbour is 12 metres and the harbour entrance is 7 metres wide which just allows for the 6 metre wide vessel to squeeze in and out. The harbour is tidal with a 6 metre range so it is necessary to operate during the bottom half of the tide from an old pier outside the harbour which had limited use due to its composition. The reconfiguration of the pier under the iTransfer project proposal will allow the extended use of the pier and encourage the introduction of viable ferry services across the Firth of Forth to destinations in Fife, such as Anstruther.

Currently the target market for this ferry service is perceived to be mainly tourists but there is seasonal work available on both sides of the river so it is anticipated that it could be used by commuters as well.

The area is protected by a SSSI status, a Site of Special Scientific Interest which means that is particularly important that our operations comply with all the latest emission controls to minimise our CO2 and Sulphur output.

A major change to the operational demands on the vessel meant that possible reductions to fuel consumption and emissions became a factor which needed to be investigated. Information gathered from other partners in the iTransfer project identified that fuel flow meters would provide the live feedback needed. Funding assistance enabled fuel flow meters and also trim tabs to be installed and tested in varying conditions and loads

Activity/method



Fuel Flow Meters

The first stage towards reducing our carbon footprint was to ensure that diesel burn was minimised and that fuel was used in the most efficient manner. In order to monitor this, the engine manufacturers were able to offer an upgrade to the engines computer control system to feed live fuel flow information to new display units which were installed on the bridge control panel. This system is able to accurately and continuously measure the flow of fuel to each injector as well as a more accurate display of engine revs, temperature and oil pressure. This was installed and has continued to produce valuable data from which we can analyse the efficiency of the engine under varying conditions particularly passenger loadings.



Trim Tabs

The other aspect of running the vessel at the most efficient speed allowed the adjustment of the fore and aft trim of the vessel known as the 'angle of attack' (originally an aviation industry term). This is adjusted by the use of trim tabs like flaps on the rear of a wing, too much angle and they add drag rather than lift and the angle required is very much determined by trial and error. The size of trim tabs currently fitted was following advice from the builder and the vessel's designer. But as this was the first of this hull shape to be used as a passenger vessel, there were indications that an additional set of tabs could be required to obtain the best results. These are currently being manufactured and will be fitted within the last weeks of the Season. As the season is quietening down it will be possible to drydock the vessel.

Biofuel Experiments

The final part the project is to test the performance of the engines using various percentages of used vegetable oil mixed in with the normal fuel. It was interesting to note that the engine manufacturer strongly recommended that it was not a good idea to introduce what is effectively recycled cooking oil into the engine. The manufacturer also warned that that this would invalidate the warranty.

Results

The installation of fuel flow meters enabled the most economic speed to fuel consumption ratio to be determined. As this is a semi-displacement vessel the trim tabs settings can at speed alter the fore/aft trim of the vessel. This was found to be an important variable under different passenger loads and sea conditions.

The results of trials were very useful, enabling the drawing up a graph of the optimum power and trim tab settings for the vessel. For example it was found that 16kts was the most efficient speed and that a 12% increase to 18kts resulted in an undesirable 20% increase in fuel consumption and carbon emissions. The final part of the project was to test performance running on a mix of gas oil and recycled cooking oil primarily for the reductions in CO₂ and carbon. The mix has slowly been increased to 10% bio-fuel to 90% gas oil with no loss of performance.

With the ever increasing costs of fuel it is crucial that fuel flow meters are part of any ferry specification. The size of trim tabs first fitted were from the best advice obtained from the boat builder and naval architect who designed the vessel however it is believed that the fitting of an additional set will further improve performance. This additional set is currently being manufactured to a new specification.

There is an optimum angle for the trim tabs as too severe an angle will create more the negative effect of drag rather than the positive effect of lift that is sought. Finding that balance for this particular vessel under differing load conditions will be very much a case of trial and error.

It will be interesting to compare results with the Weserfähre results however the performance factors for this small semi-displacement vessel will be somewhat different from a large displacement ferry.

Given the major differences in scale between the vessels this project is not expected to achieve the impressive Weserfähre results however in this environmentally sensitive area every little helps!

Staff involvement in the project was crucially important, particularly with skippers monitoring and recording the performance results of the experiments and this involvement has been important as the project has been greeted with enthusiasm and some competition to see who could complete a trip with the lowest fuel burn.

The company offered an end of season prize for the best result and one unintended bonus is the skippers are now using their skills to modify the routes slightly to fully exploit any favourable tidal currents and sea conditions.

The research carried out to date indicates that the objective of the project under way is not intended to result in the engines running on pure biofuel, there are multiple known problems with this and given the low price of red gas oil against pump prices the financial rewards do not justify risking possible damage to an engine.

However it has been proved that burning vegetable oils produce less CO₂ and carbon emissions so as this is an attractive result the project's main aim now is to ascertain that mixing up to 10% recycled cooking oil with gas oil is a viable option without causing damage to the sensitive common rail injection system in the vessel engines.

Further research into using vegetable oil uncovered the fact that the diesel fuel now purchased at the public pumps already contains 7% Biofuel and it is planned to increase that to 10%.

To date only some simple tests have been done adding small dilutions of recycled cooking oil (5%) with no apparent ill effects or loss of power. One advantage of a Catamaran is that the two engines are totally independent of each other so it has been possible to treat only one engine and compare it with the other. These tests are ongoing and it is the intention to slowly increase the percentage of Biofuel up to 10% until it is confirmed that this is causing no long term damage to the engine.

If it is possible to reduce our diesel use by 10% there is a financial gain but more importantly there are the reductions in emissions.

Premises at the harbour have been leased to store and filter the cooking oil and a collection system has been set up to bring this back for processing and mixing into batches which can be added to the vessels tanks as required. The collected oil requires to be kept warm to make filtering easier then mixed 50/50 with gas oil into a batch for adding directly to the vessel when filling with normal gas oil. It is important that the mixed fuels are kept in sealed containers until they are further diluted in the vessel tank as cooking oil is hydroscopic in that it absorbs water which is the ingredient least desired in diesel fuel.

Recommendations/Conclusions

Although the transnational partners involved in the I-Transfer operate with far larger vessels, useful information was gained from the Weserfähre project particularly in the areas of staff training. Although the results obtained are unique to a semi displacement catamaran, the information gained from this project have added to the knowledge base available for smaller ferries.

Allied to the pier reconfiguration, the fuel and fuel flow experiments have proved to be invaluable in terms of establishing the most efficient regime for the “Seafari” and together these complementary investments have contributed the iTransfer aim “.....to make ferry transport more freely accessible and sustainable, and encourage more people to travel by water”.

iTransfer is part funded by the North Sea Region programme, part of the EU Inter-regional (Interreg) initiative. Investing in the future by working together for a sustainable and competitive region, Interreg is financed through the European Regional Development Fund (ERDF).