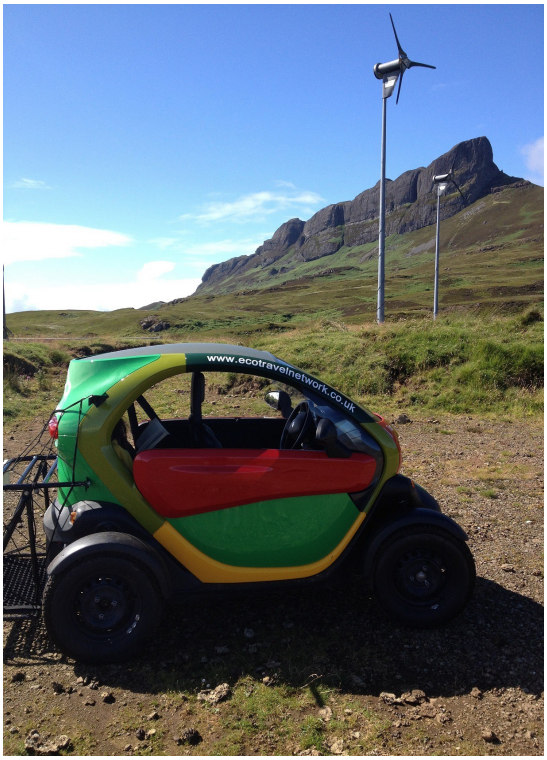
Electric Vehicle Trial on the Isle of Eigg

Alison Kidd[1] & Peter Williams

Eco Travel Network[2]

December 2014



Toro Twizy visiting Eigg's wind turbines

1 Introduction

The Eco Travel Network (ETN), in partnership with Eigg Box[3], ran a trial of a modified electric Renault Twizy ('Toro') on the Hebridean Isle of Eigg. The trial ran from July to November 2014, funded by the Green Transport prize awarded to the ETN in May 2013.

The ETN runs a hire network of low energy vehicles in partnership with local businesses in the Brecon Beacons National Park in Wales. Our aim is to encourage visitors and local residents to adopt lower energy forms of local transport which are fun to use and powered by locally generated renewable energy.

---

[1]alison@prospectory.co.uk

[2]http://www.ecotravelnetwork.co.uk/

[3]http://www.eiggbox.com/

This report describes the trial background and motivation, how the Twizy was used on Eigg and the feedback from the residents who used it. It then explores possible next steps based on the trial findings.

2 About low energy vehicles and Twizys

2.1 Why low energy?

The ETN promotes ultra low energy electric vehicles for local rural journeys. These vehicles use a fraction of the energy of "mainstream" electric cars which are trying to match the range, speed and passenger comfort of diesel/petrol counterparts. ETN vehicles focus on everyday local journeys at acceptable speeds, in acceptable comfort, using as little energy as possible. This approach should appeal particularly to small, energy self-sufficient, islands like Eigg, where range and speed are not issues but energy usage certainly is.

In the longer term, of course, this approach makes sense even on the mainland if we wish to reduce personal transport energy and make more of it renewable. But today, it is harder for mainland residents to recognise the benefit of low energy electric vehicles when the grid offers an apparently limitless supply of energy, largely from burning fossil fuel.

2.2 Why Twizys?

There are currently very few *ultra* low energy electric vehicles available in the UK. The Renault Twizy is the best (arguably the only) commercially available option.

Released in the UK in 2012, the Twizy is a 2-seater, open sided runabout with a 6kWh battery, a top speed of 50mph and a range of 45-50 miles. Designed for urban travel, the Twizy is (relatively) low price (£7k), fun to drive and interesting to look at. For ETN's purposes, the main strength is that the Twizy uses a fraction of the energy of other electric cars (120-140Wh/mile "off the wall"). This means it can be re-charged directly from local renewable energy, and since the Twizy holds so little electricity, it can use any 13amp socket, and does not need a separate charge point infrastructure. These factors all made a trial on Eigg possible, practical, and potentially useful.

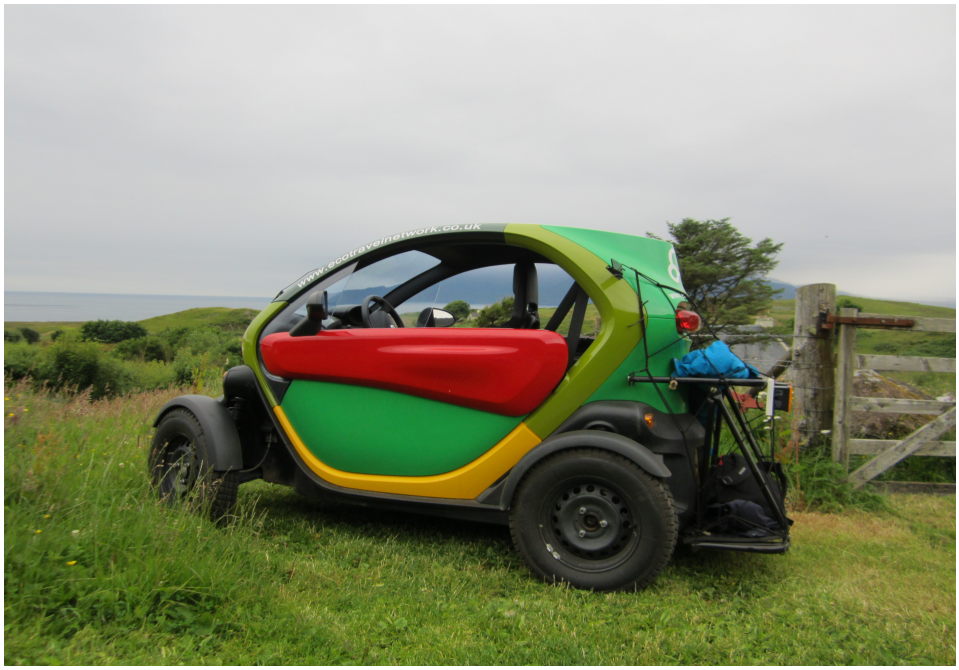
In the past 2 years, ETN members and visitors have been surprised and delighted at how well the Twizys work for everyday rural journeys, how little energy they use and how much fun they are to drive. Unlike many vehicles, Twizys appear also to be popular with other road users and pedestrians, having minimal environmental impact in terms of noise and pollutants

2.3 Why a modified version?

Designed for the urban market, Twizys have significant drawbacks for rural life: they can't carry much luggage; the thin wheels and stiff suspension may be maximally energy efficient but are ill-suited to bumpy rural roads and tracks; the weather proofing is limited; and the passenger space is restricted by the tandem layout.

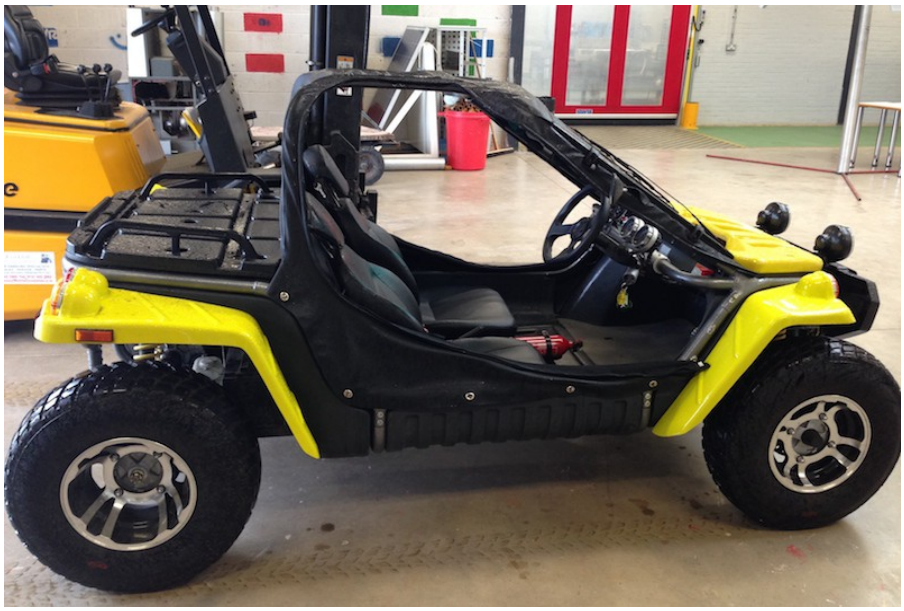
Thanks to the Green Transport Prize it won in 2013, the ETN was able to modify a Twizy in an attempt to address 3 of these drawbacks. 'Toro', the modified rural Twizy used in the trial, has bigger tyres, more flexible, raised suspension and a rear luggage rack. It was also fitted with Renault zip-in plastic windows. Unfortunately, although the Twizy has the same wheelbase as a Smart car,

reconfiguring it to provide more comfortable side-by-side seating was beyond our budget.

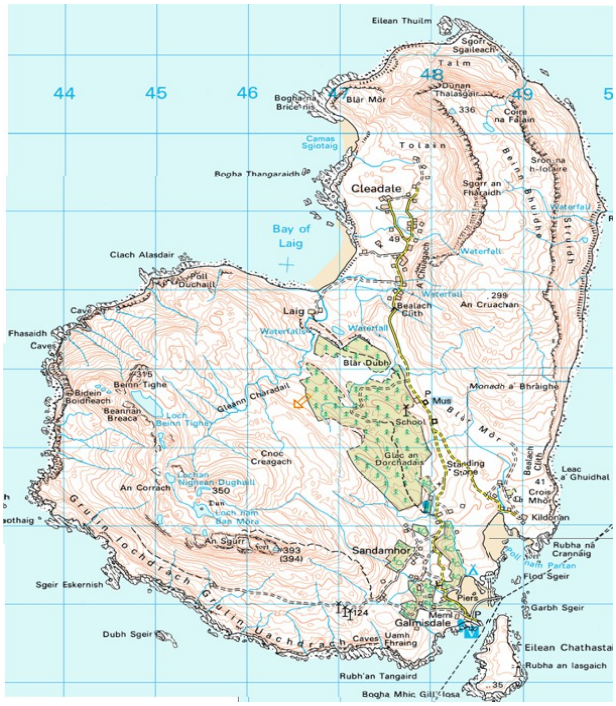


Toro, the modified Twizy

ETN also purchased a converted road legal buggy, 'Bruce', which we felt would offer a more robust option for a trial on Eigg. Sadly, Bruce has so far thrown up serious technical problems and remains in the capable hands of Edinburgh College who are attempting to make him roadworthy. In our experience, converting petrol powered quadricycles to electric operation is difficult because of the weight of the lead batteries that low cost electric vehicles tend to use.


Bruce – converted electric buggy

3 The Isle of Eigg



Isle of Eigg

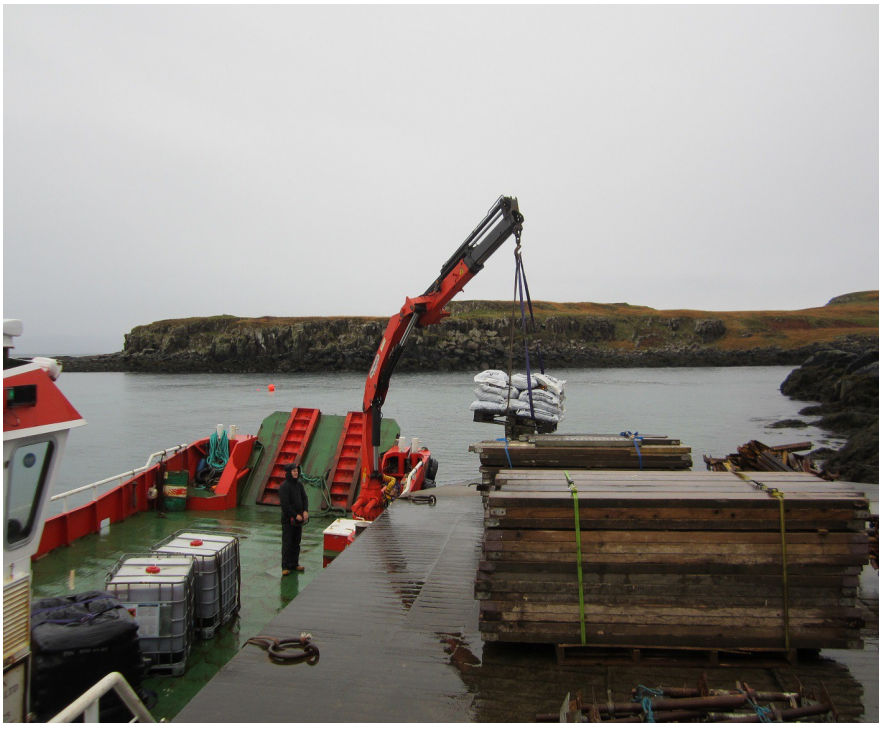
The Isle of Eigg lies 10 miles offshore and is about 5 miles long by 3 miles wide. Owned by its resident community of ~90 people, Eigg has never been connected to the mainland electricity grid but has recently developed its own world leading independent grid integrating hydro, wind and solar power to supply all the households and businesses on the island. Previously, most properties had individual diesel generators. The system relies on a bank of batteries connected to the distribution grid through a series of linked inverters. This enables the balance of demand and supply. The batteries have enough capacity to provide power for the island for periods of up to 24 hours, when energy from renewable resources is in short supply.[4]


Eigg's battery store

[4] http://www.isleofeigg.net/eigg_electric.html

Eigg Electric sets a limit of 5kW for households and 10kW for businesses to avoid overload. As the Twizy takes 2.2 kW when charging, we were concerned this might be an issue but Eigg residents are much more energy-aware than their mainland counterparts and relatively abstemious with their electricity usage. Pre-trial surveys suggested an average annual consumption rate of 2096 kWh/year (6 kWh/day) compared to a Scotland wide household average of 4863 kWh/year [5].

Transport-wise, Eigg is less green. Eigg vehicles are predominantly older diesel models and because they make only short trips of 4 or 5 miles on cold engines, they are prone to heavy fuel consumption. Given that all diesel has to be imported to Eigg by landing craft, this is a "double whammy". Using electric vehicles the island could (in principle) be self-sufficient in powering *all* its personal transport from its own renewable sources which would be truly inspiring. This would limit the expense and inconvenience of importing diesel to just the industrial and agricultural vehicles.



Spanish John Landing Craft delivering diesel and other bulk materials

Having said that, Eigg's finite grid helps focus one's attention on the exact amount of power *any* electric vehicle requires and what would happen on the island if there were many more of them. This is a problem the mainland will share if and when electric cars ever become a significant proportion of the national fleet, particularly if their individual energy consumption continues to grow at the present rate. It's just harder to recognise this issue where there's always an *apparently* limitless grid supply to fall back on.

4 Trial aims

The Eigg trial had the following aims:-

---

[5] http://www.scotland.gov.uk/Resource/Doc/933/0110153.pdf

1. To see how well a modified Twizy works in locations similar to rural Wales where neither range nor high speed are important and renewable sources of electricity are readily available.

2. To identify the design priorities for a relatively cheap, ultra low energy vehicle which would work effectively in remote rural locations.

3. To use the trial experiences to motivate the manufacture of vehicle models better designed for this low energy, rural market.

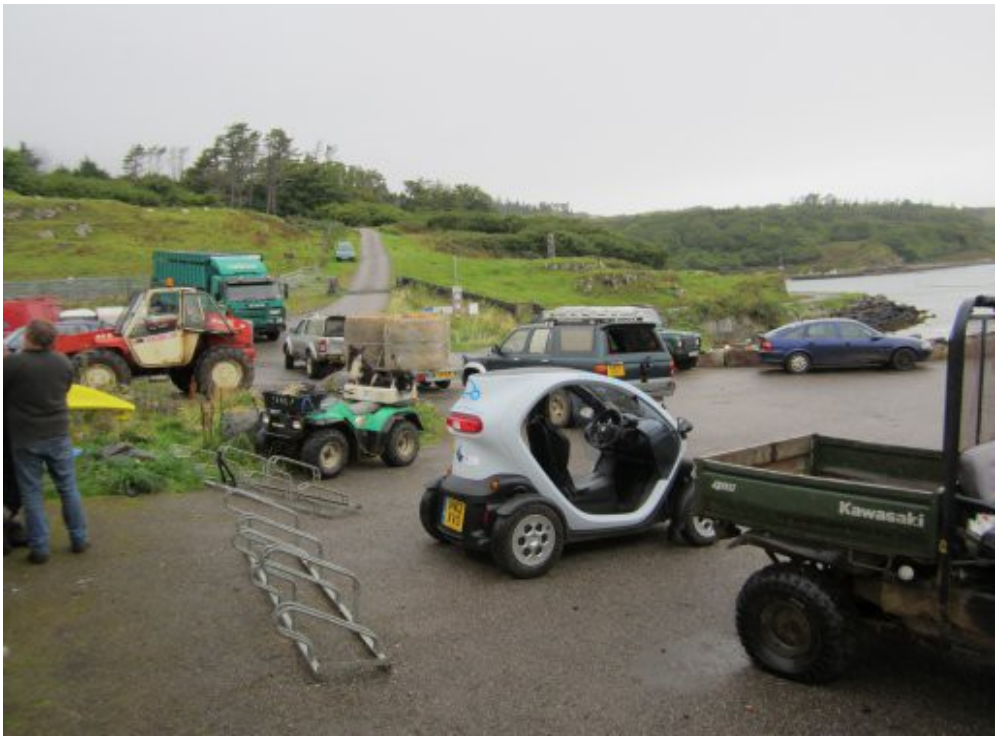
4. To explore the reduced carbon footprint and diesel cost relative to the added electricity demand (and cost) when local transport is done in a Twizy-like vehicle.

5 Vehicle use

The Eigg trial lasted 16 weeks and 14 different households used Toro for a week each during that time. The majority (10) were 2 person households. 6 of the households included at least 1 child.

All the households except two owned at least 1 vehicle. These include Land Rovers, quad bikes, pick up trucks, as well as small cars. Several people own and regularly use bicycles. The photo below (taken on a pre-trial trip in Thierry Twizy) shows a fleet of typical island vehicles meeting the ferry at the pier. We knew from pre-trial surveys that a major use of vehicles on Eigg is to collect people and goods from the pier on ferry days.

Some triallists recorded their pre-trial car trips over a week and 54% of these were to the ferry pier to collect people or goods. We realised that the Twizy would not be ideally suited for such trips. More encouragingly, only 25% of the normal car (and bicycle) trips recorded involved more than 2 people (Toro's maximum).



Typical Eigg vehicles used for transporting loads from ferry (not including Twizy)

The pre-trial surveys also showed the triallists averaging ~10 miles per day in 1 or other of their vehicles. This suggests an annual island vehicle mileage of about 3500 miles. The average trip length was 5 miles with only a handful of trips (6%) being more than 7 miles and 28% were less than 2 miles. This is hardly surprising given that the island is only 5 miles long(!) but it's interesting to note that it's not so different from the mainland UK where the average car trip is 8.5 miles long and 22% of trips are under 2 miles![6]

6 Trial Results

We had 3 sources of data on how Toro was used and what the trial participants thought. Firstly, Toro had an on-board tracker sampling his speed and location when he was moving. Secondly, triallists completed a log book with their trips and comments and lastly we ran a discussion group and 2 interviews at the end of the trial to discuss what the triallists did and what they thought.

6.1 Track data and energy consumption

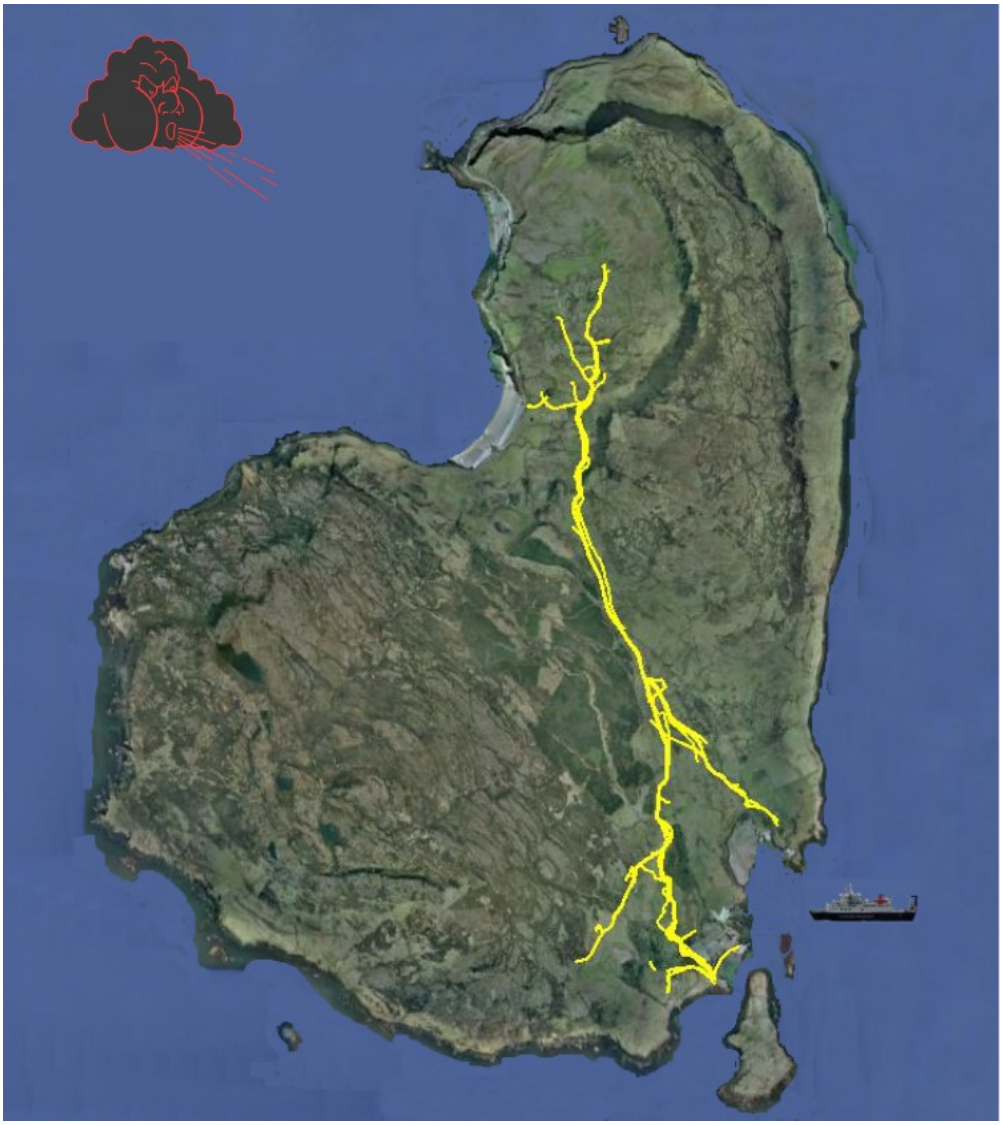
Toro's on-board tracker recorded 189 trips[7] with a total of 564 miles – an average of 5 miles a day.

The map below shows Toro's recorded trips during 1 trial month (October). Not surprisingly, they follow the 'main' 4 mile road that runs from the ferry pier in the South (Galmisdale) to the main settlement at Cleadale in the North. The tracks off this (which tend to be fairly rough) lead to different people's houses.

---

[6]National Travel Survey 2012.

[7]If the Twizy was stationary for more than 20 minutes, that counted as a separate trip.

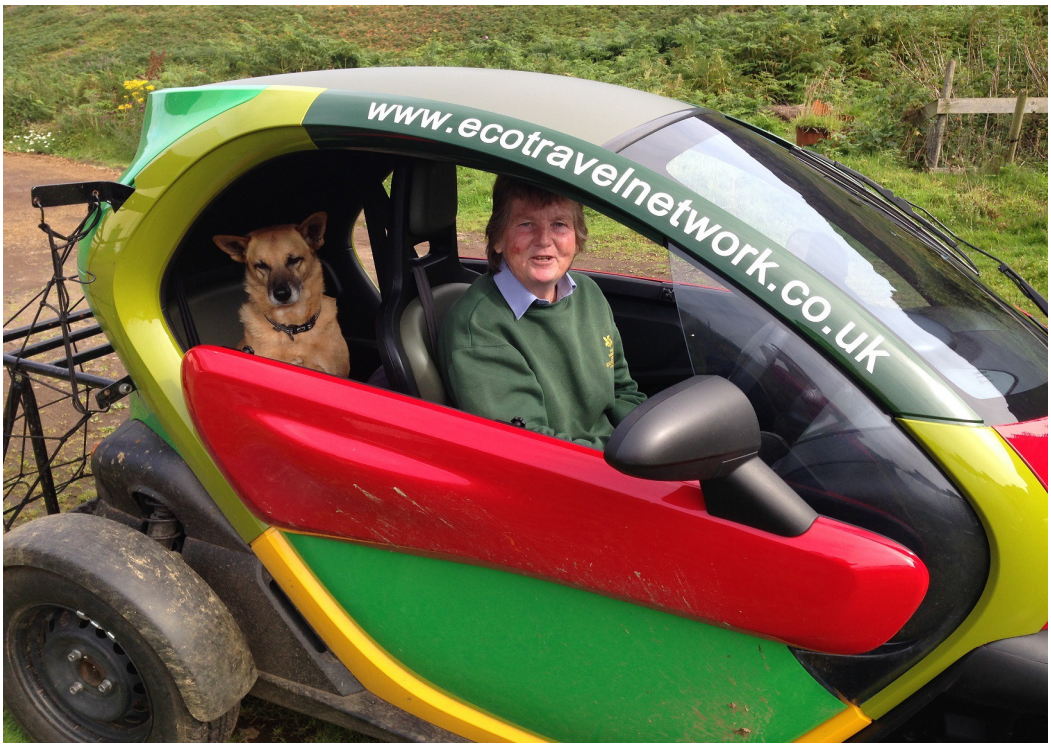


Over half of the trips (54%) were less than 3 miles and only 3% were over 8 miles. The longest "continuous" trip was 17 miles.

The maximum Twizy speed recorded was 48mph but for the longer trips, the modal speed was between 20-30mph. The average speed (4mph) reflects the shortness of most trips, stoppages and driving slowly on access tracks.

Given the Twizy's known energy consumption, this means Toro's 564 miles consumed 83.5kWh over the 3 months at a cost of £18.38 at the current Eigg Electric rate. This compares to ~70 litres of diesel costing, say, £83. It would also suggest that using a Twizy as their main vehicle might add 12 -15% to a household's daily electricity consumption.

6.2 Types of trips and uses



A combination of the log book records and the discussion group comments showed that the primary uses were as follows (in order of frequency).

Collecting and carrying stuff from the ferry

"*Pier to pick up Suma boxes – did fine with all the boxes*"

"Pier to pick up boat engine"

This use (not surprisingly) was most valued by those who normally had to rely on bicycles or wheelbarrows.

"*we did load some stuff up with it so, in that sense it was better than using the wheelbarrow – less tiring for us. In that way it was good. We put some bags of seaweed in it and the volunteers were using it for that and boxes and we did manage to pack in a fair amount of boxes in that little back bit. So for us it was a good time thing*"

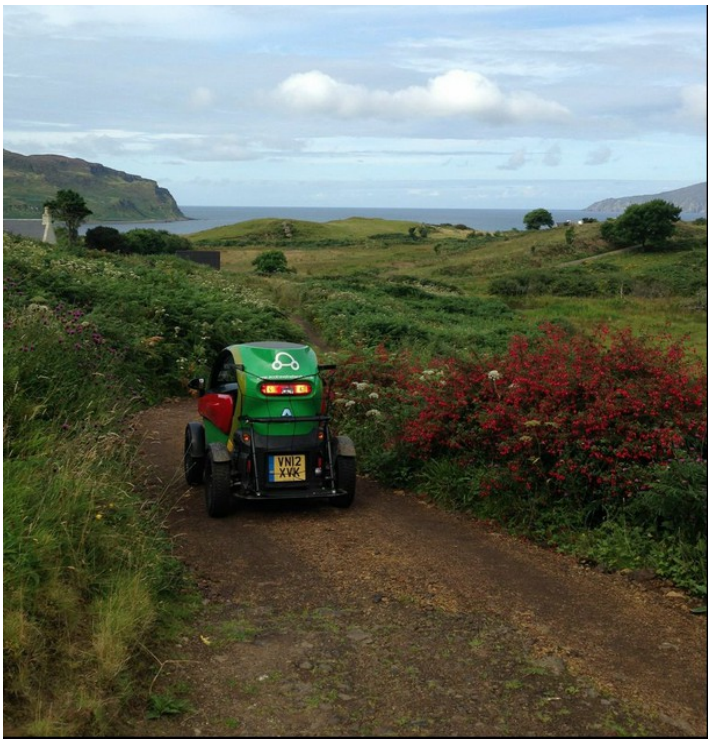
Visiting the shop/Post Office/surgery

"a quick trip down to the shop"

"getting the shopping"

"I nipped up and down to the shop a few times"

"quick trip to the surgery"

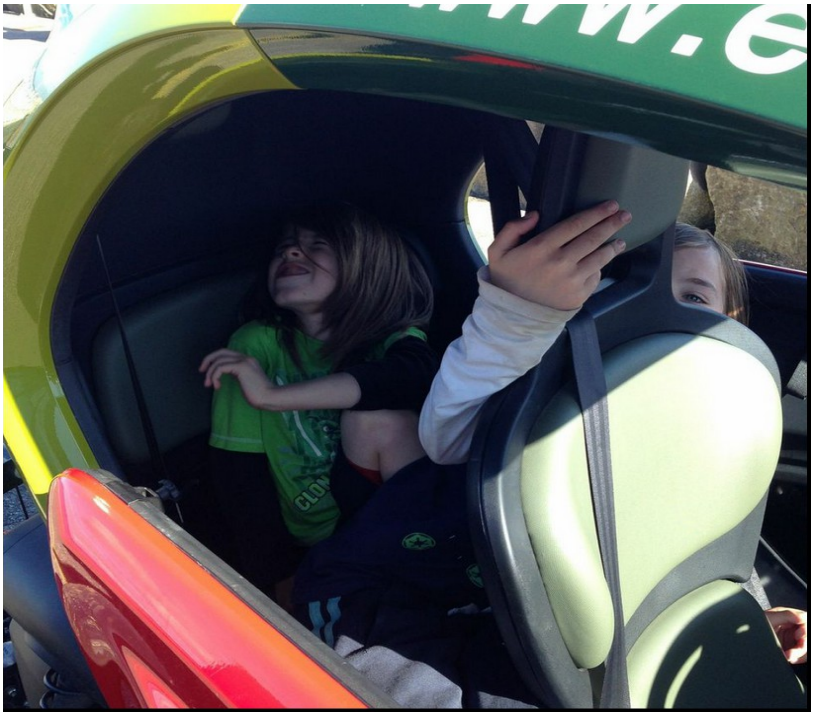


Ferrying people (and dogs)

“Almost ½ my trips had a person in the back – visitor, volunteer or hitch-hiker”

“I took someone over to the boat in it”

"took the kids to the cinema"



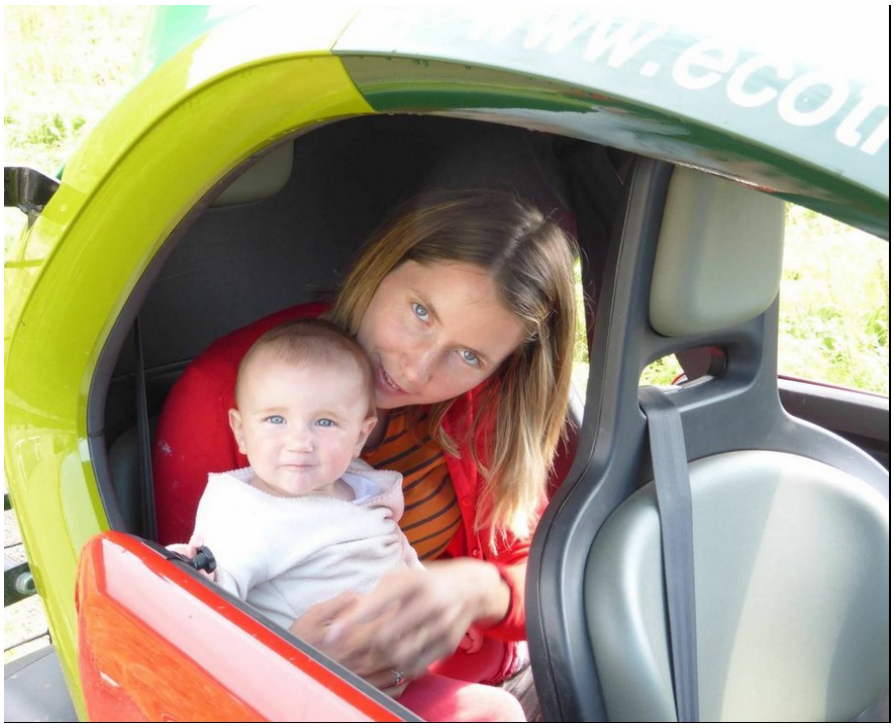
Social trips

"headed up to Galmisdale for morning coffee with the neighbours"

"to the school for the singing group"

" we went out for a drive which is not something we do!!"

6.3 Likes and dislikes



All the triallists liked the following about the Twizy:-

Fun

"it was so much fun. We just really enjoyed driving it.

"We've had a great week – lots of fun!"

"I loved the fact that everybody laughed and it put you in a good mood even if you were grumpy because everyone was smiling""

Easy to drive

"very easy to drive"

"I found it really easy to drive"

"it was more manoeuvrable than my truck"

Handy for quick short trips

"for just bombing around, that's perfect"

"for running back and forth to the shop, it's perfect"

Nippy

"it's nice and nippy"

I got it up to 47mph!"

"I drove pretty much the same speed as I would with my car"

Little electricity/charging required

"I was impressed how little it needed charging as well. I only charged it once"

"in one week using Twizy as a main vehicle, we only charged 1.5 times"

"*with short journeys, I only needed to charge it once*"

Good use of electricity

"Concept of electricity and short journeys good for Eigg"

"it's a great way of using the excess power that we have. At the moment it goes into dump heaters".

"it's a relief not to have to think about the environmental impact" (of driving diesel vehicle).

Economic to run

" I did 55 miles and I charged it and I worked out it was £1.50 which was great"

"I probably use a full tank of diesel in a week ...so, compared to that, it's very economic"

"we probably used 1 full charge during the week and we drove it quite a lot so it's very economic"

6.4 Who liked it least?

Not surprisingly, the Twizy didn't work for people who mainly use their trucks and Land Drovers for transporting stuff and multiple passengers (or family members) or who do a lot of off-road work by quad.

"for us it's totally impractical since it didn't carry very much and we carry all the time, not just things but people and dogs and things like that"

"during the summer, I'm picking people up from most boats and it will be between 2 and 4 people"

"not very practical for my job carrying lots of tools around which didn't fit in the wee Twizy"

"seeing we use vehicles to carry a lot of stuff, I thought the Twizy was maybe a little flimsy for that"

6.5 Who liked it most?

Also not surprisingly, the Twizy was most popular with people who don't have a car or who only have 1 car which is shared with their partner.

It saved them a lot of time:

"I loved it … it saved me so much time. One day I had just to go down to the Post Office and normally I'd have walked there but I got down there, posted my letter and back and still had the odd wee chat"

"for us it was a good time thing, it didn't take us so long" (to collect stuff from the ferry or shop).

It gave them a chance to be more sociable

"I really enjoyed it. It made me more sociable because I could get out and about"

"We went for a ride with Hadi and Harry (dog) was on my knee and he just chilled"

"I could meet people and say 'hello'"

Basically, **it gave them a sense of freedom** to nip around whenever they wanted

"the Twizy for me = freedom!"

6.6 Other feedback on Twizy performance and design

The following 2 features of the Twizy gave rise to mixed opinions.

Rough terrain

Whilst recognising that Toro is far from an all terrain vehicle, most people seemed happy with how well Toro coped with most of their rough tracks.

"we found it quite robust.. we live along a track that's quite wibbly wobbly bumpy"

"I was impressed how robust it was really in terms of going over rough terrain".

Although a few people seemed less happy:-

"wimped out on Sandavore track, it just felt too bumpy for Toro to handle"

"not quite rugged enough to get everywhere"

Luggage carrying

The luggage rack was adequate for the needs of some:-

"the rack on the back was very handy even though I needed to wrap my load in something waterproof"

"I carried one load with baskets and one with lots of camera equipment and shopping".

The heaviest things people reported carrying were a fridge and a boat engine!

For many though, the load carrying capacity was inadequate for their needs.

"it didn't really work for me. If I needed a vehicle to carry something, the Twizy wasn't it because I couldn't get in what I needed"

"for carrying stuff around it wasn't ideal"

The main design features which the triallists were unhappy or struggled with were:-

Passenger seat

"my only passenger found it a bit of a pain to get in the back"

"my 6 foot husband wouldn't fit in the back"

"rear is tight for anyone tall or robust"

"a bit of a squeeze for two of us"

Zip in windows

"I had a go with the windows last week for a day and they drove me potty... the irritation of getting in and out and the fact it kept steaming up and you were still wet and cold even with the windows so you might as well do without"

"the windows steaming up were a nightmare"

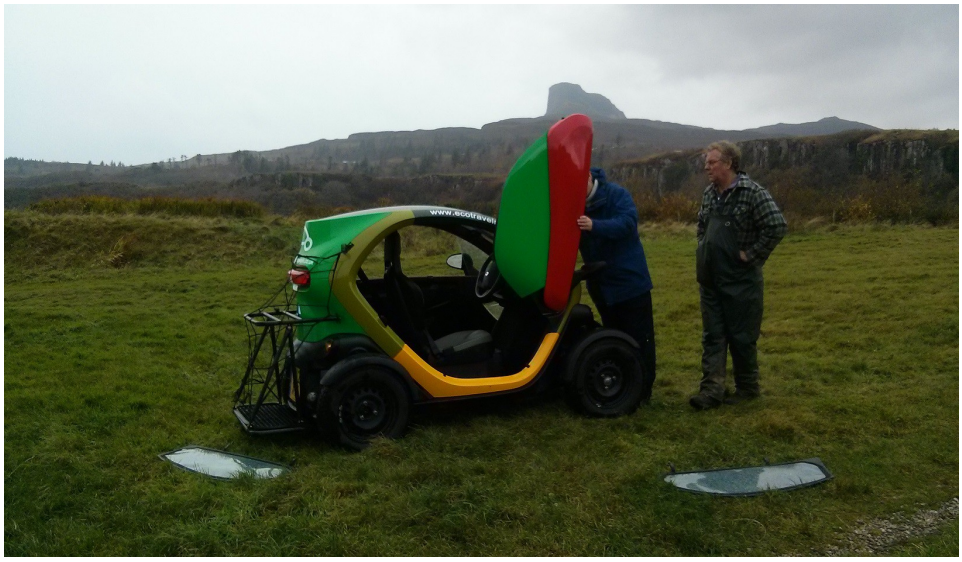
Problems with wind

Eigg is very exposed to strong winds and the Twizy doors and windows didn't cope well with this and that worried people.

"*when you open the door, if it's going to be any kind of side wind on, it's going to rip the door off or it's going to tip it over, probably rip the door off"*

"*if a gale gets them*" (the doors)

"*the windows flap around a lot when the door is open in strong winds. Once one of the windows actually flew off*"



Twizy windows and doors not designed for gales

Rain

Some people complained about getting wet especially in the back or when the wind was blowing.

"it was quite a wet week when I had it and it felt really wet, really damp inside all the time"

"very wet so no more trips today"

"I put the windows in but I still got wet"

Others seemed less concerned.

"rain on last day, I got wet but only a wee bit. As the driver I stayed drier than I expected"

"first wet trip, good wipers and rain kept at bay due to no wind. Didn't stop the midgies though!

"as long as you had your all-in-ones on, it was absolutely fine"

This seemed to be a case of whether people were thinking of it as a car (warm and dry) or comparing it with a quad, motorbike or bike with no weather protection.

"It was a shockingly wet week when we had it and I was quite dry inside because I'm used to using the quad!"

"if you think about it as a motorbike but with some cover then you sort of act differently"

"it's never going to have a heater in it because it's open so you really are talking up what you have on a bike"

Handbrake

The handbrake on the Twizy causes everyone problems until they get used to it. This was no different on Eigg.

"I found it hard to do the handbrake"

"at one point I managed to get the handbrake stuck on and it took at least 10 minutes to release it"

Mudguard

The modified Twizy required the mudguards to be welded on extended stalks and one of the two mudguards sheared off.

No noise

Although a few people mentioned how much they liked this, others were anxious about safety issues with so many walkers on the roads.

"it needs to make more noise or tourists would get run over"

"I was always worried approaching corners as other drivers couldn't hear me coming"

"I nearly got knocked down by the damn thing because it makes no noise"

7 Eigg Vehicle Futures

7.1 Requirements

The Twizy's speed, hill climbing ability, range, low energy consumption and 13amp charging were all considered excellent, if anything beyond the needs of a small island.

"*the range is great, the performance is great*"

"*on Eigg, the maximum mileage you can get is less relevant .. you're never going to do 60 miles in a day*"

"*on Eigg, you could always find somewhere to charge wherever you are"*

The key things they would like to see are:-

Trailer and/or more carrying space.

Even those who found the Twizy useful would like more carrying space and most felt a lightweight trailer could fulfil that.

"something that can carry stuff to and fro"

"a wee trailer"

"something bigger that had more carrying capacity"

More space for a passenger (and preferably more than 1)

Getting in the rear of the Twizy is a gymnastic exercise and is very cramped. Side by side seating would be preferable.

"less squashed for the passenger"

"less of a squeeze for two of us"

Some (but not all) would ideally like a larger vehicle which could carry visitors and their luggage to and from their holiday accommodation.

"carry 4 or 5 people plus luggage"

More robust

Although Toro coped surprisingly well with the rough access tracks, most felt a more robust model would be required for long term use.

"would need to be a bit more robust to cope with the terrain on a long term basis"

"I look forward to a chunkier Twizy with a trailer"

"if you could improve how robust it is"

Better weather proofing

This is a tricky one as it depends on the time of year and the type of vehicle with which it's being compared. They accept the lack of heating (as the journeys are so short) but would like something to keep out the horizontal rain and not get blown to bits by the winter gales.

"proper winter proofing needed for Eigg – no holes in the door seals etc"

"needs to cope with the really strong gales"

Low cost

People on Eigg mostly buy used vehicles for cost reasons and because of their mode of use and exposure to elements on the island.

Few could afford (or even justify) mainstream electric vehicles especially when the extra cost is for faster speeds, longer range, faster charging, interior comfort and on-board accessories that aren't of much benefit on a small island.

Maintainable

People living on islands like Eigg have to be self-reliant. Servicing and repair of electric vehicles create a problem because they are an unknown technology and the nearest electric vehicle dealer is over 100 miles away on the mainland. Either the vehicle vendors would have to provide 'flying support' or a pick up service for the islands or train someone locally to carry out routine servicing, diagnostics and simple repairs.

7.2 What are the vehicle possibilities?

The trial demonstrated that a modified Renault Twizy like Toro worked well for some people and some uses on the island and its range, speed and low energy consumption were ideal. But lack of carrying capacity, fragility, poor weather proofing and cost mean it is not the ideal Eigg electric vehicle for most people.

The maximum trip length on Eigg is short, so Eigg can exploit low energy, short range personal transport powered entirely by locally generated energy, without putting undue strain on its electricity supply. Unfortunately, mainstream electric cars are increasing their range to match conventional cars. This needs much larger batteries, increasing the weight and the electricity they use. A full size electric car may carry more people and luggage, but needs 2 to 3 times as much electricity and costs 3 to 4 times as much to buy. This isn't necessary on Eigg, and would put more strain on the island's electricity supply.

There are commercially available electric vehicles that offer short range and low energy consumption in an affordable package. None of them deliver everything that every Eigg resident might need in terms of ease of use, passenger and cargo capacity, weatherproofing, and low electricity usage. But any of the following types would find some application:

1. UTV's and buggies
2. Quad bikes
3. Scooters and Motor Bikes
4. Bikes
5. Rickshaws
6. Full size electric cars and vans
7. EV platforms

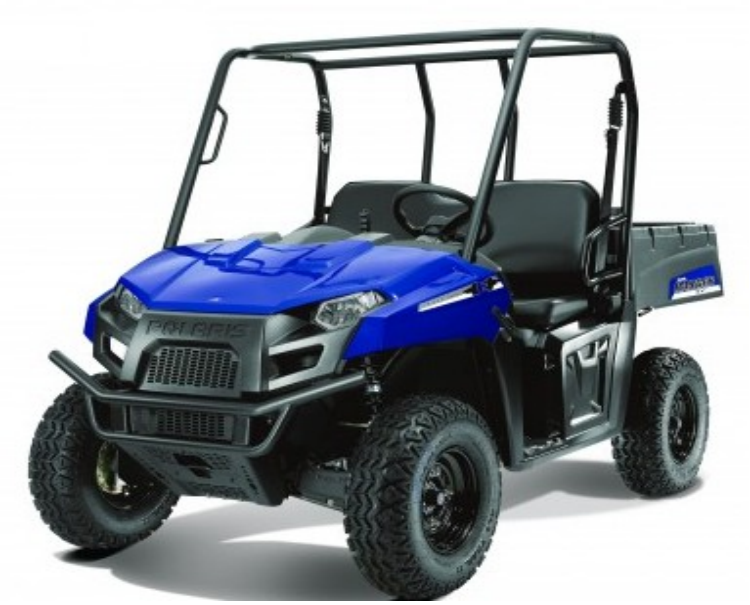
7.2.1 UTV's and Buggies

Golf buggies, airport passenger transport and "campus maintenance" utility vehicles have been around for years. They operate at low speed (15 mph) within a short distance (5 to 10 miles) of their overnight power supply. They use simple motors, lead acid batteries, and are (fairly) easy to look after because they use established technology.

There are also more rugged agricultural electric "utility" vehicles with higher performance and off-road capability. These tend to be electric versions of diesel and petrol models, sold on the basis of running cost and quiet operation, and tend to cost 30% to 50% more than their conventional counterparts. They can carry a passenger and/or half a tonne of cargo.

The vehicle shown here is the Polaris EV, on sale in the UK for a little over £13,000[8].

[8] http://polarisbritain.com/atv-ranger/ranger/ranger-ev/features.html



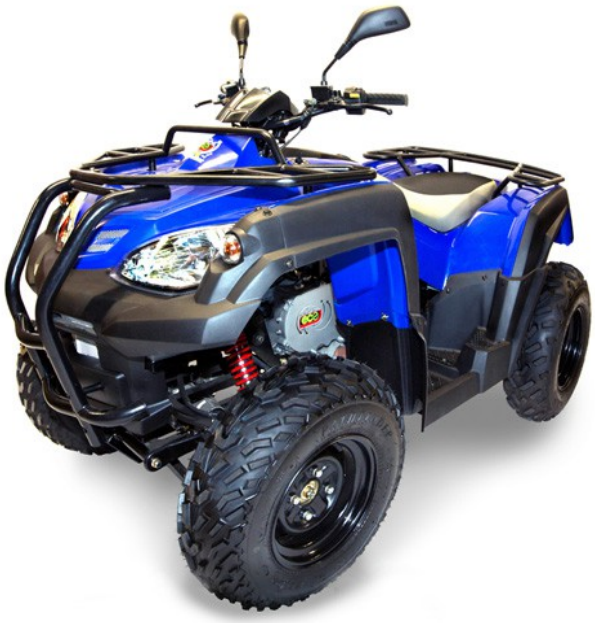
This vehicle has a 48V 30hp induction motor. It has 4wd and is designed for off-road use. It has 11.7kWh of lead acid battery giving it a range of about 30 miles. Weatherproofing is extra.

7.2.2. Quad bikes

Quad bikes are mainly off-road vehicles, offering moderate road performance but able to carry cargo and a passenger. Electric quad bikes are all (as far as we know) converted petrol or diesel models and tend to use lead acid batteries and conventional gearboxes and differentials which limit range and add a lot of weight. The result is a specialised vehicle that is quite a bit more expensive. While range limitation isn't an issue for road vehicles on Eigg, it would (if our experience in Wales is anything to go by) be an issue for off-road vehicles which may not actually travel very far but use a lot more energy per mile than road vehicles do.

Here is a quad bike converted in the UK[9]:

[9] http://www.electric-quad-bikes.com/index.php?main_page=product_info&products_id=4



It has a 72V DV motor of about 20hp, is 4wd, and has a range of about 30 miles at up to 30mph (though not, I imagine, at the same time!). It has 7.2kWh of lead acid battery. It costs nearly £12k, but you can buy a 2wd for less than £10k.

Quad bikes are difficult to drive, and consequently not as safe for untrained drivers. They do not provide weatherproofing.

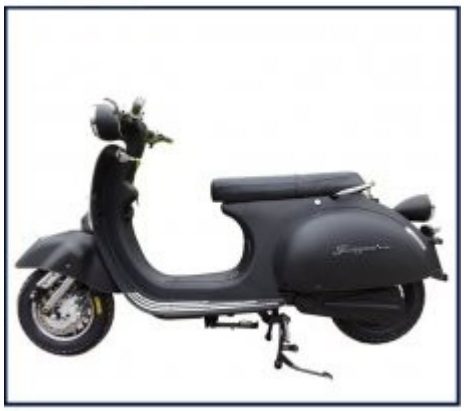
7.2.3. Scooters and Motor Bikes

Converting an existing motor scooter or bike to electric power is difficult because of battery weight. The electric scooters and motorbikes on the market are therefore, in the main, re-designed as electric vehicles and use second and third generation battery and motor technology. But in other respects they are just like normal motor scooters and bikes, and may require training in addition to regular driver training. They are very energy efficient, but not as easily weatherproofed as a four wheeled vehicle.

Since this is the kind of vehicle that China and India needs at the moment to power their growing populations at reasonable cost and without suffocating their cities, these kinds of vehicle are mass-produced and can be very cheap.

Here is a very cheap one, the eco Zippy[10]:

[10] http://www.ekobikes.co.uk/?_route_=electric-moped/zippy



It does about 30mph, has a 2kw motor, about 1.2kwh of lead acid battery and will probably carry you 20 to 30 miles. It costs about £1350, and for that price it would be unreasonable to expect memorable build quality. There are models with better reputation and lithium batteries for less than £3000.

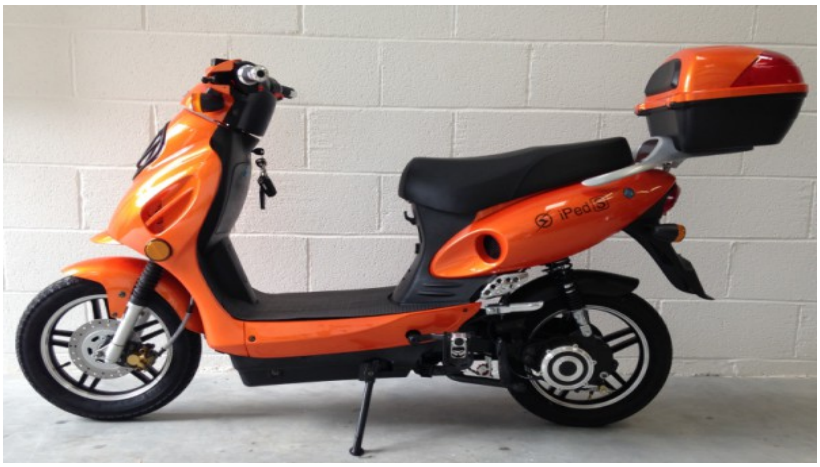
These will be like any other motor scooter to drive, and you will need a driving licence, insurance, and a helmet. There is no weatherproofing.

7.2.4. Electrically Assisted Pedal Bikes.

These are the most energy efficient forms of powered personal transport, offering power assistance up to 15mph and effectively making pedal cycling a low effort activity. They don't require any special training, a driving licence, road traffic act insurance, or a helmet, but their cargo and passenger carrying ability is limited.

Having said that, the legislation regarding power assisted pedal bikes does allow slightly higher powered motors (250W) in a "tandem" bike, and this has encouraged the emergence of a new class of power assisted pedal bike that looks to all intents and purposes like the scooter above.

Here's a recently launched model 'iped' marketed by a UK company[11] – though the bike on which it is based comes from China.



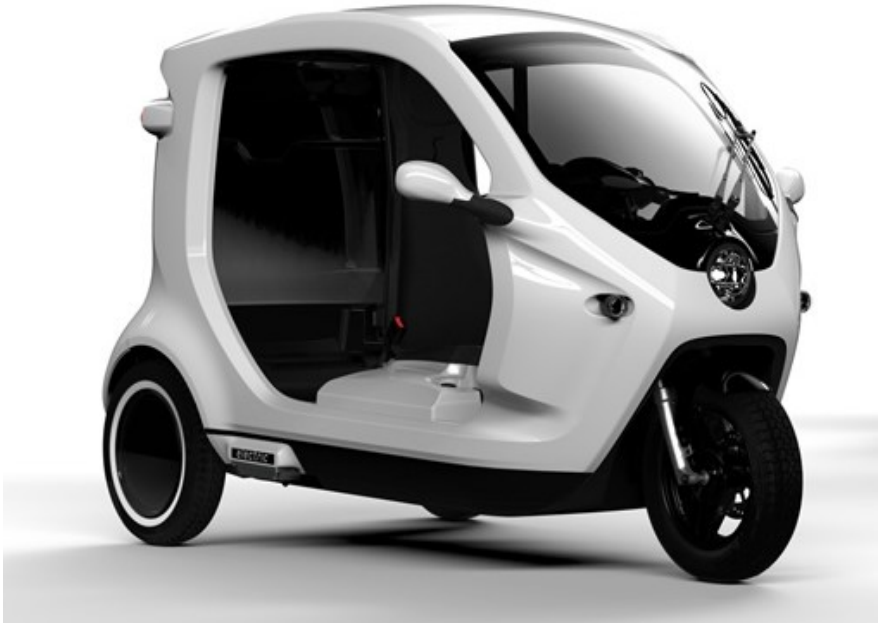
[11] http://www.eped.co.uk/shop/iped-type-s/

It has cargo bins and a pillion and can technically be pedalled if necessary, but does not actually *require* you to pedal. They are limited by law to 15mph, but using second and third generation battery and motor technology they offer a very low cost electric vehicle that most people can drive safely. It has a 250 watt motor and a 15mph motor-assisted top speed – both limited by law. But it's supposed to do 50 miles and has nearly 2kWh of lithium battery.

7.2.5. Rickshaws.

In many Asian countries, powered rickshaws (called tuk-tuks because of the noise they make) are a popular taxi and family transport. In addition to the driver they can carry either two people or significant cargo. While there are converted petrol rickshaws there is now a purpose-built very lightweight *electric* rickshaw called the Zbee entering mass production in Singapore[12].

In Europe, when and if this vehicle goes on sale, it will be classified as a light quadricycle (the Twizy is classed as a heavy quadricycle). This means the motor is limited to 4kW and the maximum speed to about 28mph. We don't know the likely price yet, but it should be cheaper than the Twizy when it is mass-produced. This vehicle can be weatherproofed but we don't yet know whether it will cope with rough road surfaces. Here's a picture of a Zbee:



As you'd expect, it is a three-wheeler with a driver in front with two passenger seats or a flat bed load space behind. They promise fuller weatherproofing for Northern Europe, which looks feasible.

7.2.6. Full Size Electric Cars and Vans

These have all the weatherproofing, passenger and cargo carrying of a normal car, and similar performance other than range, though that is not an issue on Eigg. As mentioned above they typically cost 50% to 100% more than a conventional cars and vans, and it would be difficult to recover the difference in

[12] http://cleanmotion.se/zbee/

price from the reduced running cost of imported diesel versus locally generated electricity.

In 10 years time, we can expect to see a few of today's electric cars on Eigg, just as we see many 10 year old conventional cars today. But it would be hard for an Eigg resident to justify buying a new one now, even with the government subsidy of £5000 per vehicle.

7.2.7. Open Source Electric Vehicle Kit

All the electric vehicles we've looked at so far have advantages and disadvantages, and there doesn't appear to be an ideal vehicle which meets the modest personal transport needs of most of Eigg's population. Some might find one or more of these electric vehicles would work for them, but the market for short range, high efficiency electric transport is not large or well-served. So since Eigg's transport needs are somewhat singular in market terms, perhaps the best way forward is to find a way to build an "Eigg Electric Vehicle" at reasonable cost that satisfies the island's particular needs in terms of, for example:

1. Range (say 25 to 30 miles).
2. Speed (say 30 to 40 mph max).
3. Passenger capacity (2 or 4).
4. Cargo (say half a cubic metre on a rack or a tow bar)
5. Terrain (forestry road standard).
6. Weatherproofing (rain and wind resistant)
7. Maintenance

This vehicle would need to be as maintainable on the island as current vehicles, but given the nature of EV technology, it might be more practical for it to be "modular" with components like motors, controllers, battery packs etc. replaceable "in the field" from stock items that are (relatively) readily available, rather than individually repairable.

Building one's own vehicle from scratch is a tall order, and doing so for a reasonable price even more so but there is an (Italian) initiative promising to deliver a basic drive train of floor chassis, suspension, motor, batteries, wheels, brakes, and steering leaving the actual "body" to the customer or OEM to furnish to their own requirements[13]. Like Toro, the resultant vehicle would be classed as a heavy quadricycle in the EU.

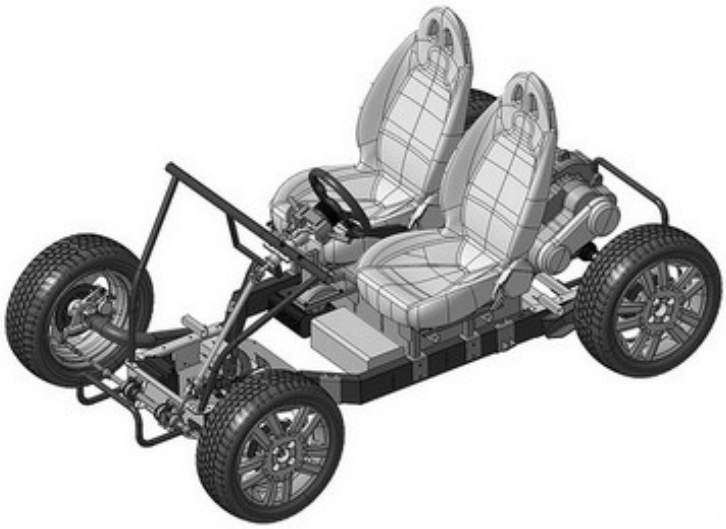
So far, this concept exists as a set of freely downloadable specifications but prototypes have been built in two and four seat configurations. The long term goal is a set of standards and specifications that any manufacturer can adapt and build elements of, making for a market in interchangeable components but with custom bodies and chassis provided by local suppliers for different markets.

This is currently a technological dream, but if it comes to fruition, it might provide a realistic platform for an Eigg vehicle which might have a (small) market elsewhere.

Here's a diagram of the bare rolling chassis. This is an electric version with two seats and space of a luggage rack at the back. The 4 seat chassis is simply

[13] https://www.osvehicle.com/tabby-info/

longer – all the other components would be the same. The body, and in particular the weatherproofing, is left as an exercise for the coach-builder. It is in some senses a return to the early days of motoring, where mechanical engineers built the chassis, and coach-builders created the body.:



The ETN is monitoring developments of this 'Open Source Vehicle' concept to see if there is sufficient take-up for component and chassis manufacturers to emerge to serve the market. It's a nice idea, though, and if it becomes a reality might come closest to providing an "ideal" solution for short-range, ultra low energy, rural transport.

8 Next steps

We moved Toro to Knoydart in November to continue the Twizy trial in a slightly different environment. Toro will be there for the next 3 months and the trial is being managed by the Knoydart Foundation Ranger Service.

The Eigg community are reflecting on their trial experiences and what they might like to do next. A couple of the triallists have expressed interest in purchasing Toro (either as ETN members or as an independent purchase) with the aim of reducing costs by sharing his use with each other as well as occasionally with fellow residents and visitors. At the trial feedback session, the group did discuss reducing cost of an electric vehicle via community ownership and community use. However, similar to our own experiences in a rural Welsh community, they have found shared ownership, responsibility and use is a complex social arrangement. As with anywhere else, people on Eigg prefer the convenience of a personal vehicle which is ready to go when they want to go and is cared for and looked after by the person who most values it.

However, it might be that a shared vehicle *insurance* policy of the kind that ETN operates for its vehicles could work for Eigg where each vehicle effectively belongs to the member who hosts it, pays for it, uses it and cares for it but the vehicle can be used by anyone or hired out to help cover running costs. This model avoids the community ownership issues whilst enabling multiple users and some cost sharing.

The ETN hopes to continue to collaborate with the isle of Eigg to further our shared interest in motivating the design, production and use of affordable electric vehicles for remote rural areas.

9 Conclusions

In the 3 month trial, Toro the modified Twizy was used by 14 households, did 564 miles and consumed 83.5kWh at a cost of about £18 (Eigg Electric rate). This compares to about 70L diesel at a cost of about £83.

Most Eigg residents who took part in the trial liked Toro and found him easy and nippy to drive and handy for quick trips to the shop, pier, school or surgery or to visit friends and neighbours. They liked his speed, hill climbing and the fact that he uses so little power that he rarely needed charging. Everyone (including us!) was impressed with how well the modified Twizy coped with some of the rougher tracks on the island. The rear luggage rack proved adequate for smaller loads (from rucksacks and shopping to fridges, boat engines and seaweed!) and was most appreciated by residents who usually relied on bicycles or walking.

On the other hand, Toro didn't work for people who mainly use their vehicles to carry large loads and/or multiple visitors (plus their luggage) to and from the ferry or for those who mainly work off-road. A Twizy towing a light trailer would immediately add to its uses and users.

The trial showed that the restricted speed (50mph), range (50 miles) and sparse comfort of a vehicle like the Twizy, together with its readily-available 13 amp charging, are perfectly adequate for an island like Eigg and indeed exceed their requirements. Where the Twizy fails to satisfy island needs is principally space for carrying (or trailing) more people and goods, robustness for use on rough access tracks and better weather proofing/more robust body to cope with horizontal rain frequent gales. From the manufacturers point of view, a vehicle that traded some speed and range for carrying capacity and ruggedness would be perfectly acceptable.

Islands like Eigg, along with many rural areas, need cheap, personal transport more than their urban counterparts do. This is because facilities (shops, schools etc) are beyond easy walking distance, access to public transport is sparse or non-existent, fuel is much more costly and scattered dwellings make car sharing impractical. The good news is that such rural locations can be served quite adequately by modest electric vehicles because everyday journeys are short (so no range problems or need for expensive charging infrastructure), roads are slower and many rural areas and islands already generate enough renewable electricity locally to power such vehicles themselves.

The sad irony is that there are currently almost no commercially available low cost, ultra low energy, electric vehicles (a.k.a. quadricycles) which are robust enough for rural use. And the few electric quadricycles that do exist don't qualify for *any* government subsidies while the higher end/higher energy electric vehicles all do![14] Mainstream electric vehicles command higher prices because of their higher speed, faster acceleration, more comfort and ever longer range. This demand for longer range electric cars to match conventional cars means heavier batteries which, ironically, raise the kWh per mile and reduce energy efficiency.

---

[14]Some of the latest high end electric vehicles eligible for government low carbon subsidies are no longer even low carbon!

Rural dwellers doing short trips don't need the same level of speed, range and comfort. What they need is carrying capacity and robust suspension.

The ultra low energy concept vehicles that manufacturers parade from time to time seem to be targeted at the urban market and, like the Twizy, have minimal passenger or luggage space, narrow energy efficient wheels, stiff suspension and limited weather protection.

In terms of environmental impact, the good news on Eigg is that any household replacing their diesel vehicle with an electric vehicle would save 1 tonne CO2 per year. However, a growth in such vehicles would impact Eigg's current generation capacity. If 23 of the households on Eigg switched to a low energy vehicle like the Twizy as their main form of transport, the additional electricity consumption would require an extra 6 kW wind turbine. If they adopted mainstream electric cars, it would be one wind turbine for every 8 households. The same is true for mainland UK but here the additional energy consumption of electric vehicles tends to be overlooked because of ready access to the National Grid.

The trial has broken new ground for small electric vehicles and been enormous fun for all those involved. We would like to thank Edinburgh College and the Green Transport Prize, and Lucy Conway of Eigg Box for making it possible. We hope the results and their implications for electric vehicles in rural areas might help inform Scottish sustainable transport initiatives and UK government policy regarding the types of vehicles and charging points which they subsidise. We also hope to inspire designers and manufacturers to explore the potential for low energy, low cost electric vehicles which work well in rural locations but look rugged and trendy enough for Chelsea residents to purchase as a lifestyle statement!