b-bug

rain-powered transport

The b-bug report

An eco transport trial in the Brecon Beacons

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"going out in the b-bug was an adventure not just a journey"

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Executive Summary

From June to October 2011, The Prospectory ran a trial of two electric, road-legal buggies ("b-bugs") in the Brecon Beacons National Park. Visitors and local residents were invited to take part in the trial.

The b-bugs, Boris and Blodwen, were designed and built by Dragon Electric Vehicles and part funded by the Welsh Assembly Government. They had a top speed of 30 mph and a range of around 25 miles. They travelled 7 miles on 1 kWh of electricity. 20 local cafes, pubs, activity providers and tourist attractions formed a voluntary charge point network for the trial.

30 people took part in the trial - using a b-bug for 3-5 days. A further 50 tried a b-bug for a short joy ride. The b-bugs totalled 1500 miles and climbed 150,000 feet. They averaged 145 Wh/mile and consumed 290 kWh of electricity. The longest recorded trip was 33 miles and the maximum recorded speed 48mph with an average trip length of 9 miles and an average speed of 16 mph. Most of the driving was on small country lanes (where driving is necessarily slow) and 25% trips involved climbs of over 1000 feet.

The b-bugs inspired visitors to leave their cars behind and travel around the Brecon Beacons in a different and more enjoyable way. They did this because it was fun, they loved the open air and every journey felt like "an adventure". It also changed how they holidayed. They explored local lanes, visited local attractions, ate at local pubs and enjoyed local activities. using their cars much less (or even not at all) during their stay. This was in direct contrast to our previous findings where visitors travelled an average of 50 miles by car a day often leaving the National Park completely.

Local residents found the b-bugs' speed and range fine for commuting to work, making quick trips into town for shopping and ferrying their children to school or other activities. They would happily swap using the car for using a b-bug for these short daily journeys because it's more enjoyable, cheap and handy.

The b-bugs appealed because they were funky and fun rather than because they were green. Their greenness was seen as a nice 'by-the-way' although the 1500 trial miles actually consumed less than 20% of the electricity produced by one set of domestic PV panels in the same period.

The trial showed there is real potential for an ultra lightweight, short range, electric vehicle which is not trying to be a car but can replace short rural journeys in hilly rural terrain where public transport is often not an option and cycling is challenging. But to work, it has to be both enjoyable and cheap.

If visitors could hire such vehicles, this would change their travel patterns in ways that are good for the environment of the National Park and good for the local economy. They would also give the Brecon Beacons a promotional edge as an eco-tourism destination.

Finally, the trial demonstrated that an informal charging point network, based on local tourist businesses, is fine for supporting lightweight electric vehicles, can readily evolve and brings additional business to the participants.

1 Introduction

The b-bug project won the Green Dragon's Den competition at the Hay Festival 2010. An award of £10k from the Welsh Assembly Government[2] helped fund the design and build of two electric, road legal buggies for a trial with visitors and local residents in the Brecon Beacons National Park (BBNP) in summer 2011.

Our inspiration for the trial was two-fold.

1. In a study in 2010[3], we found that visitors to the BBNP average 300 car miles during a 1 week stay. They drive 14 miles on average just to reach the start of a walk or other outdoor activity and most visitors drive to the local pub or shops *even if they are only 1 mile away*. How could visitor travel in the National Park be made more environmentally benign?

2. Given the difficulty of providing adequate public transport in sparsely populated areas, residents of rural Wales are very car dependent. 95% of Powys residents commute to work by car and 90% of these journeys are less than 25 miles[4]. Even for journeys of less than 3 miles, 77% still use the car. The hilly terrain makes cycling unattractive for many. Could a small electric open vehicle provide a practical alternative to the car for these short journeys and how well would such a vehicle cope with our hills?

2 Aims of the b-bug trial

The b-bug trial had 3 main aims:-

1. **To inspire visitors to get out of their cars** and experience a greener form of holiday transport which is both funky and fun.

   Green initiatives are too often worthy but dull. We wanted to show that green can mean fun and interest.

   Encouraging people to do something differently and disrupting long-held habits has been shown to change outlook and subsequent behaviour[5].

2. **To explore the possibility of "not-cars" for short rural journeys** for both visitors and local residents.

   Electric cars have to emulate the performance & range of petrol cars, as far as technologically possible, if they are to replace them. This means that, like petrol cars, they use for more energy than is necessary for most of the trips they make. It also makes them very expensive. Is there space in the market for ultra lightweight electric vehicles which can manage short local

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2 http://wales.gov.uk/topics/sustainabledevelopment/funding/sdchallenge/;jsessionid=q2LLMbFQWw4vl3TJvD1rC4ZQ9vy1zg8PWlnhDdvlPDDFnhwC1hFq%21-2029259793?lang=en

3 http://theprospectory.files.wordpress.com/2011/08/b-bug-visitor-travel-report.pdf

4 http://wales.gov.uk/docs/statistics/2011/110324wts2010ch6ency.pdf

5 http://www.youtube.com/watch?v=PxrtUV_DPPM

trips at low financial and energy cost without any frills? This is what we mean by a "not-car" - something that is not even trying to be a car.

What would be a reasonable compromise of battery weight, speed, range, weather-proofing and cost?

What kind of rural charging structure needs to evolve to support these?

3. **To demonstrate the power of clean, locally-sourced hydro-electricity**.

We dubbed the b-bugs "rain-powered" to bring home how much of our travel needs could be met from sustainable energy sources. For example, Talybont-on-Usk community hydro scheme[6] could keep 150 b-bugs on the road.

We also liked the idea of putting a positive spin on Welsh weather by telling people 'if it rains on you today, that's the power to drive tomorrow!'.

3 About the b-bugs

Our trial partner, Dragon Electric Vehicles,[7] designed and built 2 electric, road legal 'b-bugs' (short for Brecon Beacon buggies).

Boris

Blodwen

Boris and Blodwen are converted Hammerhead 250 petrol buggies. They have 6kW electric motors directly driving the rear wheels, powered by lead acid batteries holding about 3kWh of useful power at the high currents required. They can carry two people 25-30 miles at a top speed of about 30mph. At this range and speed, an efficient electric vehicle can be built cheaply using relatively inexpensive technology. The b-bug trial explored the extent to which its limited range and speed can meet local travel needs in the National Park.

Blodwen has two chains to improve hill climbing and also has regenerative braking. She is however a bit slower than Boris and a bit noisier.

[6] www.talybontenergy.co.uk

[7] http://www.dragonelectricsportscars.co.uk/

Most electric cars now use lithium batteries, which have the higher energy density needed for longer distance trips, but much higher cost. Boris and Blodwen occupy the "sweet spot" on the electric vehicle cost-performance curve for established lead acid battery technology. To go further or faster using lead acid batteries means a greater proportion of vehicle weight being devoted to the batteries, and accelerating or lifting that weight uses proportionally more of the increased energy capacity, eventually becoming self-defeating. But lead acid batteries can deliver the 3kWh necessary for a 30mph/30 mile range in a very lightweight vehicle more cost-effectively than lithium batteries. A 3kWh battery can also be recharged quickly from a domestic supply using cheaper chargers.

Any vehicle of a given weight and aerodynamic profile requires the same amount of propulsive power, but electric motors deliver that power more efficiently than combustion engines because less energy is wasted as heat. So, even if the electricity in the battery came from burning fossil fuel in a power station, less fuel is needed to power an electric car. b-bugs are very efficient precisely because they are light and do not go very far or very fast. Because they don't go very far, they can afford smaller batteries and so use less energy climbing hills and accelerating. Because they don't go very fast, they don't use as much energy overcoming air and rolling resistance.

As a measure of this relative efficiency, even early prototypes like Boris and Blodwen can transport 2 people at less than 140 Watt-hours per mile, or around 7 miles per kWh. A production b-bug should be able to do much better than that. A normal car uses a litre of fuel to travel 10 miles, and since a litre of fuel contains about 10kWh of energy, this is about 1 mile per kWh[8].

A full re-charge of an exhausted b-bug takes around 7 hours using a 13 amp socket but 7 miles could be recovered within the first 1-2 hours. A 2 hour recharge would be feasible with a higher power charger.

As the b-bugs are the first ever electric, road legal buggies, Dragon Electric Vehicles and The Prospectory spent 3 months testing, modifying and retesting the engine, controllers and chargers before the trial started.

4 How the trial worked

4.1 Insurance, recruitment and trial partners

The original plan was for the b-bugs to be sited at local caravan/camping sites and rented out to visitors on a half or full day basis. This would enable us to find out what visitors would be prepared to pay and enable caravan sites to explore b-bug rental as a potential business opportunity.

Unfortunately, we discovered it wasn't possible to insure the b-bugs for hire[9]. We therefore had to change our plans and loan the b-bugs to trial participants, directly from The Prospectory for people to drive on their own car insurance. Comprehensive "drive other car" policies stipulate that no rental fee can be charged, which meant that we couldn't conduct a rental business experiment. On the plus side, however, it gave us the freedom to allow people to trial the b-bugs

[8] This doesn't quite make b-bugs 7 times as efficient as cars, because power stations aren't 100% efficient either, the grid loses power in transmission, and battery chargers aren't 100% efficient.

[9] In short, buggy insurance companies cover private but not rental insurance and, conversely, insurance companies which cover vehicle rental don't cover non-standard vehicles like road-legal buggies.

for a prolonged period (from 3-5 days) which provided us with a much more realistic test of their viability as alternative transport, and much better feedback.

A local holiday cottage agency and several B&B's, hotels and campsites helped us promote the trial to their pre-booking customers. They mostly did this via their own websites. In turn we promoted them as b-bug friendly places to stay.

Would-be triallists were invited to book a b-bug for 3-5 days free use in return for their feedback.

4.2 Equipping and instructing triallists

At the start of each trial, we delivered a b-bug and instructed triallists on how to drive it and gave them a demo run.

Each b-bug had a large plastic box on its luggage rack to hold shopping and other gear. The box also contained an extension cable, a waterproof vehicle cover and security lock. We also provided a simple user guide, a technical guide, a list of 20 b-bug charging points and OS maps with the charge points marked on them. To help subjects plan their use we produced customised b-bug guides suggesting reachable destinations and back road routes and mileages from their accommodation.

The b-bugs were equipped with a Cycle Analyst[10] which provided the interested driver with dynamic readouts of miles (since last reset) voltage, ampere hours, watt hours and watt hours/mile. In the absence of any other indicators, we advised the triallists to check the rest voltage on the Cycle Analyst before setting out (and mid-trip) and use a graph displayed in the lid of the luggage box (see Figure 1) to calculate roughly how many miles they could still run. The graph (which was based on actual b-bug runs during road testing) also gave them a feel for the variation in range depending on terrain and driving styles.

[10] http://www.ebikes.ca/drainbrain.shtml

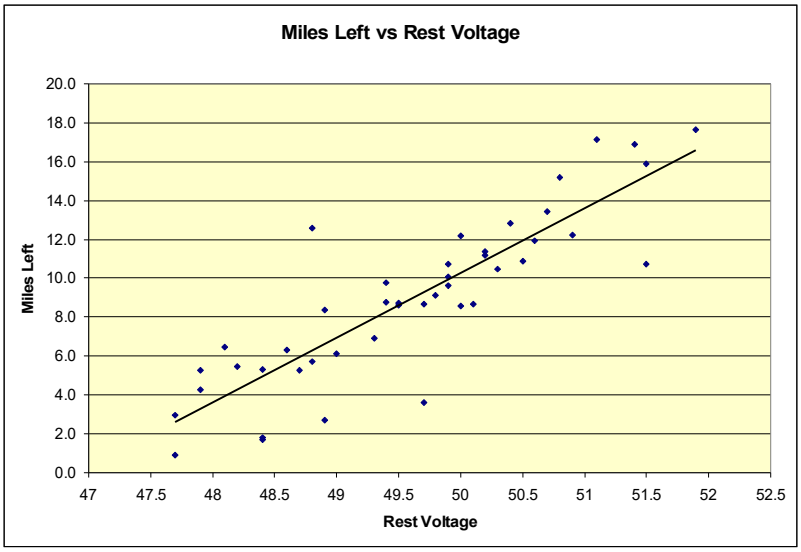


Figure 1 : Graph showing miles left based on rest voltage reading

The b-bugs also had satellite trackers which recorded the latitude, longitude and altitude of a moving b-bug every 5 seconds. These managed to record 131 separate trips in some detail, to supplement the feedback from the subjects.

At the end of each trial, we conducted a structured interview to gather feedback on what people did with the b-bug, their experiences (good or bad) and their feedback on the b-bug concept and its potential. We also asked them to complete an online survey.

4.3 b-bug charge network

With the help of the Brecon Beacons Tourism, we recruited 20 local businesses (pubs, cafes, tourist centres, shops and activity providers) as charge points. Each offered space to park a b-bug and access to a 13 amp electrical socket. The businesses could charge for this but as far as we know none chose to do so. They realised that any purchase of goods or services (from a pint of beer to a canoe hire) would cover the electricity cost which was mostly a 1-2 hour top up worth 20p at most.

Venison Centre

Talgarth Mill

Figure 2 shows the map of some of the 20 b-bug charge points.

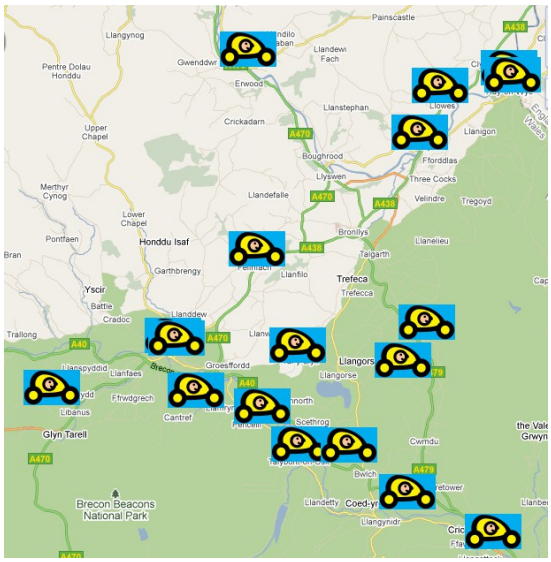


Figure 2 : Map of b-bug charge points

As far as we know, this is the first ever informal electric charge network in a rural area.

4.4 Trial launch

The trial was officially launched at the 2011 Hay Festival where Boris was used to ferry Festival staff in and out of town and for demo rides for a diverse collection of visiting dignitaries ranging from Jason Bradbury of the TV Gadget Show to John Griffiths, the Minister for Environment and Sustainable Development in the Welsh Assembly Government. The b-bug attracted huge interest wherever it went.

Jason Bradbury

John Griffiths AM and Andy Fryers (Hay Festival)

The previous autumn, HRH Prince Charles encountered an early b-bug prototype at the Start Festival in Carmarthen and subsequently asked to borrow 2 b-bugs for a weekend at his Llwynywermod estate, near Llandovery. He was therefore technically the first trial subject along with an enthusiastic bunch of royal police protection officers who joyfully discovered the mud splattering possibilities of b-bugging at speed over rough ground.

5 Who took part in the trial?

The trial ran from June through September 2011 with 30 (couples, families or individuals) taking part – each using a b-bug for 3-5 days. Another 50-60 people drove the b-bugs on a short joy ride just to see what it was like.

Of the 30 triallists, 16 were visitors and 14 local residents. 18 were men and 12 were women. 16 drove Blodwen and 14 Boris. The visitors who took part were staying in an equal mix of B&B/hotels, self catering cottages and caravan/camping sites. They came from all over the UK.

Figure 3 shows the age profile of those participating:-

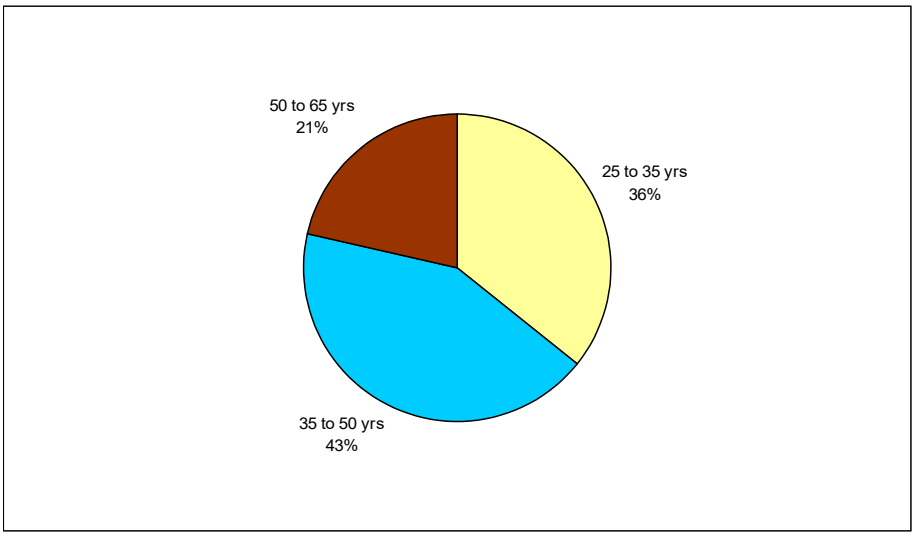


Figure 3 : Age profile of triallists

In the post-trial survey, we asked triallists how interested and/or active they were in adopting a low carbon lifestyle. Figure 4 shows their responses.

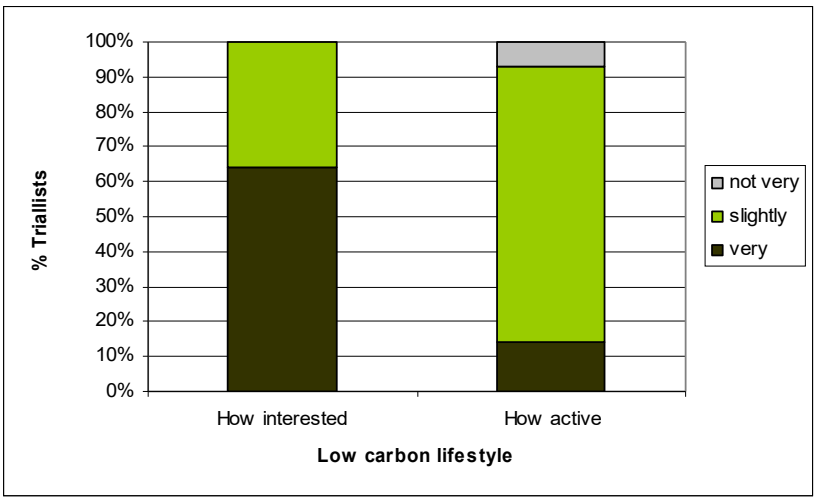


Figure 4 : Triallists' environmental interest and activity profile

It is no surprise, given the nature of the trial, that it attracted participants who were mostly very interested in reducing carbon, although only a few described themselves as particularly active in this regard.

Only 1 of the 30 triallists had any previous experience of driving an electric car.

Unfortunately, we had to reject a further 10 applicants either because of booking clashes at weekends and peak holiday periods or the lack of the right kind of insurance.

As the b-bug is open to the elements, the weather is a factor. Figure 5 shows the daily weather (as reported by triallists for their trial period).

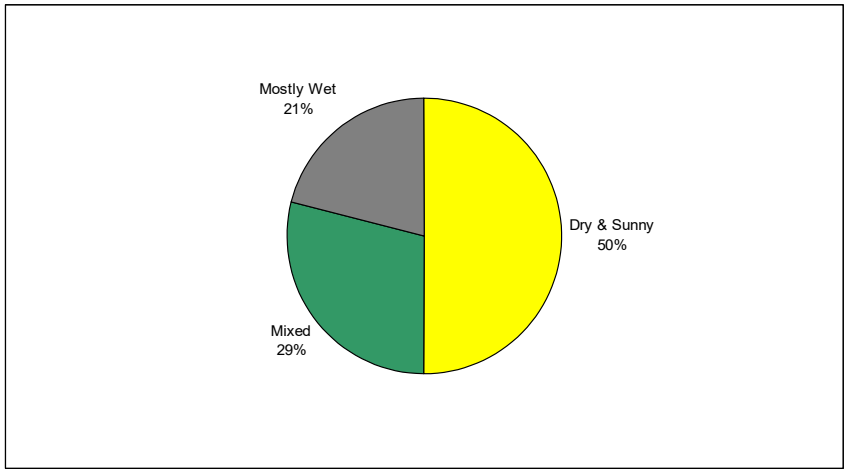


Figure 5 : Percentage of wet and dry days during trial periods

Despite it being a poor summer, only 21% trial days were recorded as wet. According to the Met office, 23% of days a year are wet in Wales.[11]

6 What did people do in the b-bugs?

Over the whole trial, the b-bugs totalled 1500 miles between them and climbed 150,000 ft (5 times the height of Everest). They averaged 145 Wh per mile and consumed roughly 290 kWh of electricity[12].

6.1 Trip lengths

Figure 6 shows the length of the recorded b-bug trips made by both visitors and residents.

[11] http://www.metoffice.gov.uk/climate/uk/wl/print.html

[12] As a point of comparison, our own domestic PV panels generated 5 times this amount of electricity over the 4 month period of the trial.

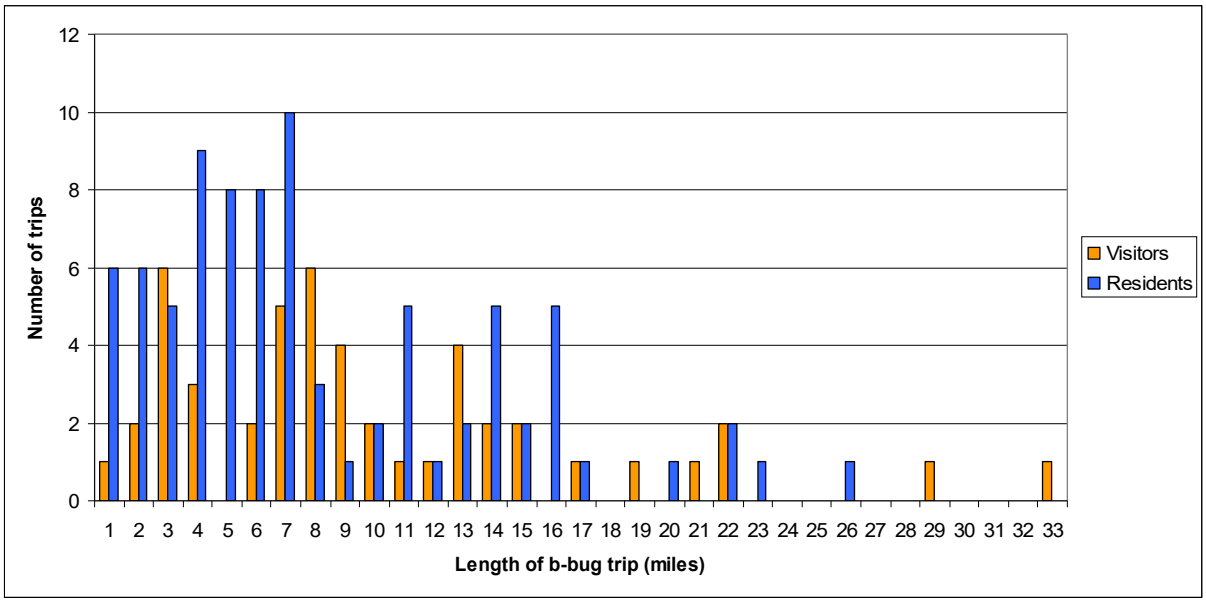


Figure 6 : Frequency of trips of different lengths (visitors and residents)

The average trip length was 9 miles and the median[13] 7 miles. The local residents made more short trips with half their journeys being less than 6 miles. Even so, 4 of the locals had work commutes of over 10 miles (1 way). The longest single recorded trip was 33 miles (by a visitor) but we are not sure how exactly this was achieved!

6.2 Example visitor trips

The following examples (from the satellite recorders) give a feel for how the visitors used the b-bugs during their stay.

[13] Meaning half the trips were less than 7 miles and half were more.

Example 1 : Couple camping for a 3 day weekend North of Brecon

Figure 7 : Blodwen trips made from Priory Mill campsite in Brecon

This lady and her partner b-bugged to the National Park Mountain Centre for a walk and cup of tea (green track), Brecon for shopping (yellow track) The Star Inn in Talybont for supper one night (red track) and the Pwllgloyw Inn for supper the following night (blue track). They covered 53 miles in 3 days only using their car once for an evening trip to the theatre in the pouring rain!

Example 2 : Couple staying on caravan site in Pencelli.

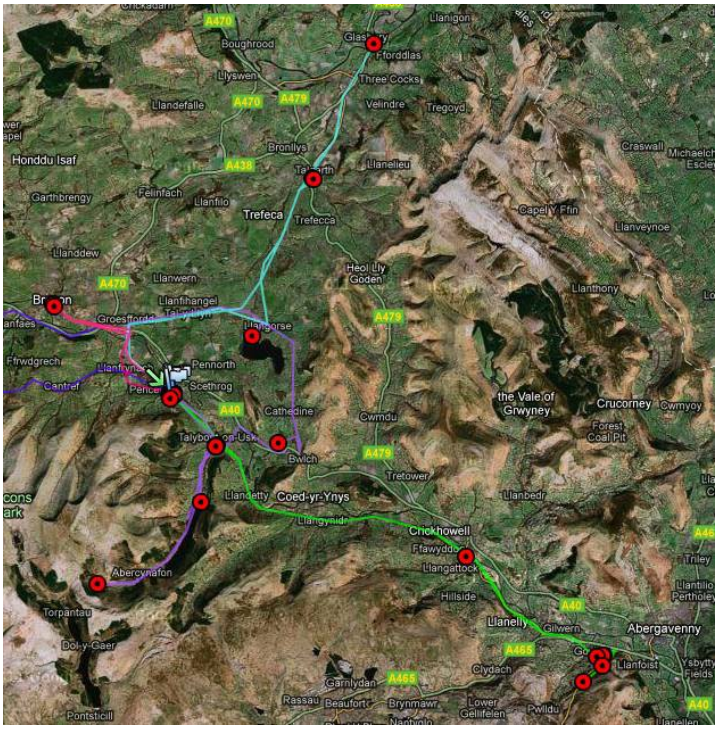


Figure 8 : Boris trips made from Pencelli Castle Caravan Site

This couple were our most ambitious triallists. They didn't use their car once in the 5 days they had the b-bug. They covered 140 miles using multiple charge points to add interest to their trips and to extend their range. They visited tourist attractions, hired canoes, did all their shopping, collected take out meals and generally explored the local area. They even signed up a couple of new charge points (including a British Waterways Office) when they ran low on power!

6.3 Purpose of visitor trips

Figure 9 shows the declared purpose of all the different trips made by visitors.

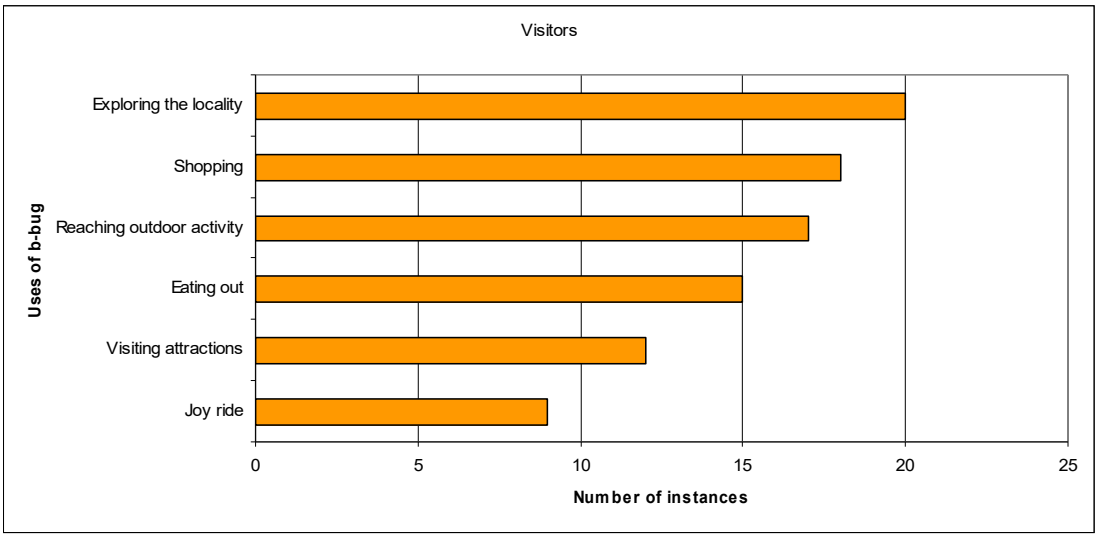


Figure 9 : Purpose of b-bug trips by visitors

Most frequently, visitors described using the b-bug simply to explore the immediate locality via the country lanes. This was followed by visiting the local shops, reaching a walk or other outdoor activity (mostly canoe hire), eating out and visiting attractions. A 'joy ride' describes a trip that had no purpose other than enjoying b-bugging.

Pub lunch in Talybont-on-Usk

Hiring a bike in Hay-on-Wye

6.4 Purpose of local resident trips

Figure 10 shows the different purposes of local residents using the b-bugs.

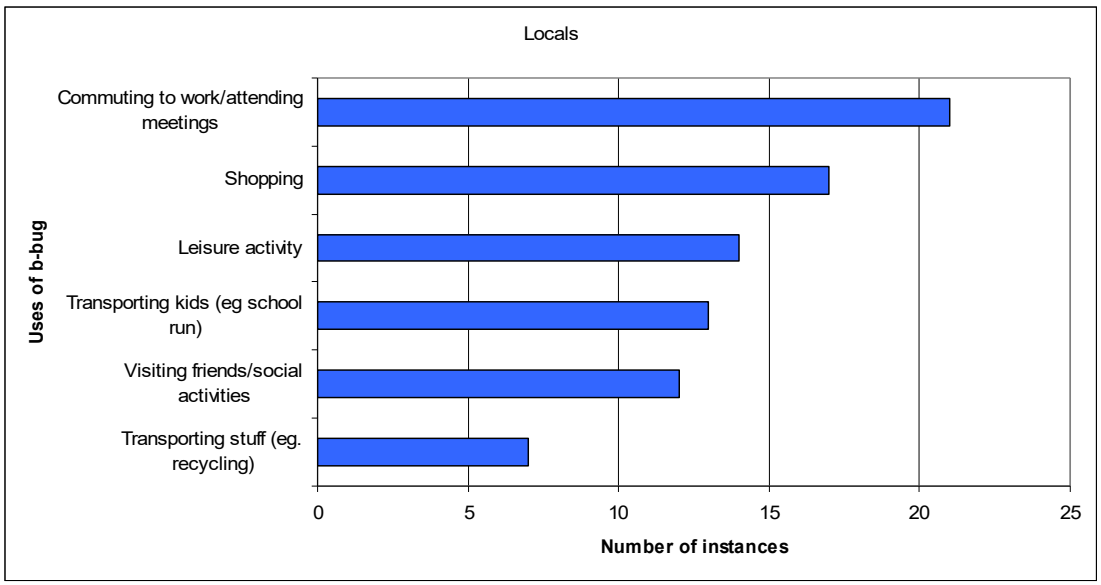


Figure 10 : Purpose of b-bug trips by residents

The local residents mostly used the b-bug as a means to reach their workplace or other work-related meetings. But they also found the b-bugs useful for quick shopping runs into town, ferrying children to school or other activities, leisure activities and socialising at weekends.

Commuter arriving at work

Ferrying schoolchildren

One lady used Boris to commute 5 miles to work each day but found it very handy in the evenings for ferrying her children to village activities and daily visits to an elderly relative – all within 1 mile of home (see Figure 11). The b-bug enabled her to carry stuff and tackle the hilly routes better than walking or cycling. She resented using her car for such short trips.

Figure 11 : Tracks of resident using b-bug for local trips

6.5 Driving speed

The most frequent maximum recorded speed for Blodwen (the slower b-bug) on any trip was 30mph although she did once reach 35mph. Boris frequently reached 35mph and beyond and he once reached an astonishing 47.8mph (hurtling down a hill on a major road with only 1 aboard). However, given these differences in capability, the average speed for the two b-bugs across all their trips was remarkably similar – 16.2mph for Boris and 15.6mph for Blodwen.

We managed to collect a small amount of control data from local cars driven on short trips. The average speed in these cases was around 30 mph.

Different b-bug drivers showed very different speed profiles depending on their driving style, length of trip, and terrain. Some drivers only averaged 7mph across all their trips whilst others averaged over 20 mph. All the work commute trips, for example, averaged 19mph. This could be because people didn't want to waste time and the routes were very familiar to them.

Figure 12 shows how the average speed increased with the length of trip.

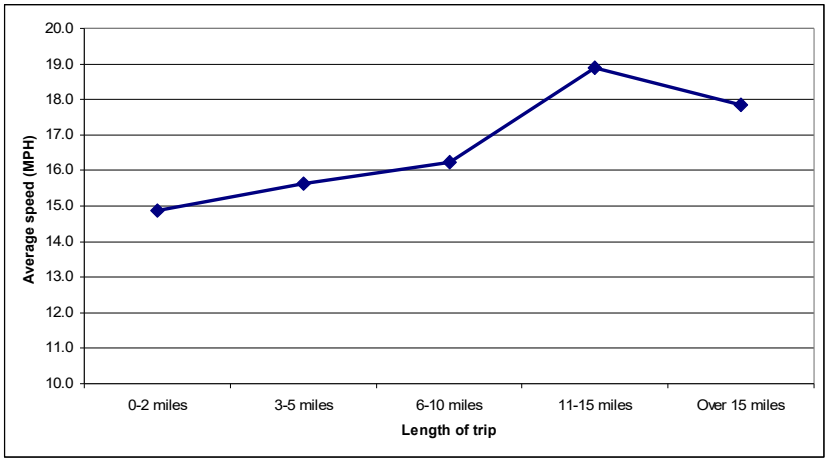


Figure 12 : How average speed varies with trip length

The average speed increased until 15 miles when it dropped slightly – probably reflecting people's caution with regards to range.

The b-bug speed was also seriously affected by gradient and 25% of trips in our undulating terrain involved climbs of over 1000 ft with one long trip climbing a total of 2800 ft (not all at once!). One local commuter climbed 1500 feet a day in Blodwen simply to get to work!

7 What did people think of the b-bugs?

7.1 What did they like?

70% of the triallists loved using the b-bug and were reluctant to hand it back. The remaining 30% enjoyed it but were less enthusiastic. The latter didn't use the b-bugs much – usually because they had small children or the weather was very wet. Overall, the triallists staying in tents or caravans used the b-bugs far more and were more adventurous and enthusiastic than the triallists staying in self-catering cottages or B&B.

We categorised all 750 post-trial interview and survey comments and counted the number times each was category mentioned. This gives a feel for what is important in the minds of the triallists. Based on this linguistic analysis, Figure 13 shows the main ways in which the b-bugs appealed to both visitors and residents.

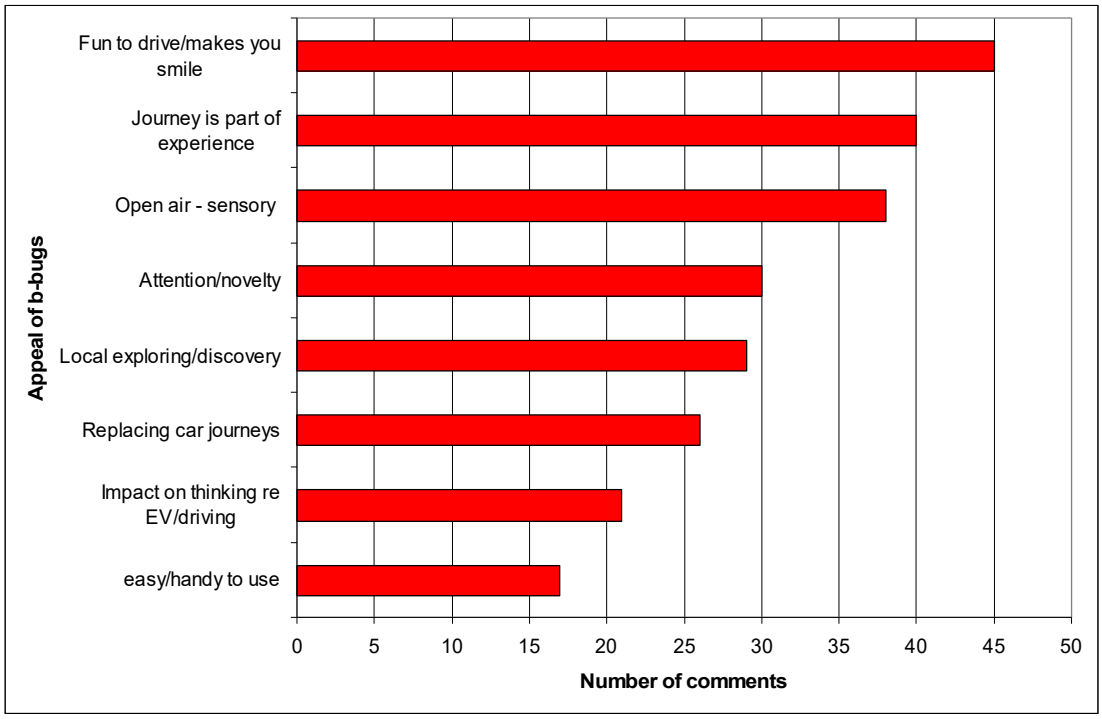


Figure 13 : Why the b-bugs appealed to people

Here are some examples of each of these values. In most cases, people were making a direct comparison with using their car.

1. **Fun to drive**

"It was so much fun. Puts a smile on your face and anyone who sees you smiles too"

"That's the most fun I've had in a vehicle for years"

"It's much more fun than a normal car. It's just fun"

2. **Journey is part of the experience**

Chatting to locals en route

Exhilarating night time ride back from the pub

"Going out in the buggy was an adventure not just a journey"

".. you behave differently with it from the car. We made a couple of trips that we wouldn't have made in the car and we did some things which we wouldn't have actually done … because of the fun of doing it"

"The b-bug turns going somewhere into an event, doesn't it - we loved it"

3. **Open air – sensory**

"It's better than the car and more open and that was one of the lovely things. The whole sensory experience was brilliant for the kids – they were commenting on the smells – we drove past a field where they'd obviously just mown it. The smell of hay and I noticed today coming here, the smell of silage. Things like that"

"That's one thing I enjoyed about the b-bug, coming up today, you notice sounds and smells. You can hear things and you're more aware of what's going on. This back lane smells fantastic at the moment because they've cut all the hedges. You're just completely isolated from that in a car"

"suddenly coming up the Warren road, I got above the cloud, the view opens out and you can't help but smile and in the b-bug you're part of it""

4. **Attention/novelty**

"everywhere we've been, there's been people flocking around having a look"

"the experience of taking it to the café at Glasbury, people all gathered around and talked to us – it was fantastic and that experience wouldn't have happened if we hadn't been in the b-bug"

5. **Local exploring/discovery**

"I'll tell you what it was good for – just to explore the area. That's mainly what we've used it for so we've probably done like longer drives in our car but then, on a night, we've thought 'oh we'll just have an hour just sort of go down little country lanes'…"

"I went right up the hill, tracked around the lanes up there for a while, trying different roads. I hadn't been up there much before"

6. **Replace car journeys**

"On the positive side, it actually did nearly all of our travelling on this holiday. Almost all of it. We used our car twice"

"there's quite a long car journey down here and back with a heavily laden car but you turn up here and then you don't use the car for a week"

7. **Impact on thinking about electric cars and travel**

(Only 1 triallist had had previous experience of driving an electric vehicle.)

"I do think that people would use an electric car if they knew it was that easy. I think people think it's a huge hassle"

"This has been a great start to me looking at low carbon cars"

8. **Easy and quick to use and charge**

"to get to the shop, you didn't have to get the car out all the time. You could just hop on the buggy"

"Plugging in was brilliant – just came in, plugged in, off we go and at home time, unplugged. Somebody said "oh it's your portable hairdryer"

In fact, according to one triallist, charging the b-bug was quicker and easier than refuelling his car.

"..we spent less time faffing around with the b-bug than we would have done going to petrol stations. There are 2 petrol stations on the way to Hay but you have to stop off, fill up the tank. With this, park it right outside the tent, plug it into a socket that's just there and that's all you've got to do"

Given that refuelling a car at a petrol station takes 5 minutes and completely recharging a b-bug takes 6-7 hours, this is a curious perception. The clue lies in the fact that recharging a b-bug 'at home' over night does not take up any of your time whereas driving to a fuel station to fill up is always a diversion which does. In rural areas as well, the nearest fuel station might be 10 miles away.

Some other values were mentioned by a few people –

funky cool look *("it's so cool – I passed a load of kids and they were saying cool man"*)

economics *("I worked out every time I took Blodwen to work and back again I saved myself about £7.50's worth of diesel"*)

chance to travel slowly *("on the way down I was not stressed as I usually would be if I was late for something, the b-bug really makes you slow down, it's brilliant"*)

environmentally friendly - given the aims of the trial, we were pleased that the b-bugs' green credentials were not cited as their primary appeal. They were seen as an incidental factor. This quote sums up people's attitude - "*it's fun to drive, it gets you where you want to go and, by the way, it's green. Whereas so many other (green) things, you do it and you put up with a lot and you sacrifice a lot because it's green whereas here the green is kind of a nice little aside".*

Counting the synonyms which people used to talk about the b-bug trial reveals much about the impact it had. The top 3 synonyms were "*fun/enjoy*" (270 mentions), "*think/thought*" (218) and "*hills/steep*" (176). This suggests that the fun was the dominant emotion but using the b-bugs was also thought-provoking and people worried a lot about hills! In contrast, there were less than 30 synonyms for "*green/environment"*.

7.2 How did the b-bugs affect the holiday?

A number of the visitors said that the b-bug had actually made their holiday.

"the b-bug made our holiday"

"our holiday was Boris … the Boris holiday in the Brecon Beacons"

"this has made the last few days of our holiday"

In one case, the visitors had opted to come to the Brecon Beacons because of the opportunity to take part in the trial.

Most importantly, the b-bugs changed the entire shape of people's holiday –

"the b-bug changed how we holidayed and what we did"

"you have to think entirely differently, you have to get in a different mode"

The biggest effect was that people chose to spend their time (and money) locally – exploring the immediate locality, finding local walks, local attractions and local places to eat. This was in stark contrast to our 2010 study where people drove an average of 50 miles a day in their cars to achieve similar purposes.

Boris at waterfall walk

Boris crossing Trericket bridge

"being tethered to a 10 mile radius didn't hamper our trip – it enhanced it! It honed your sites closer to the campsite, We would never have visited Pwllgloyw Arms if we were without the buggy"

"if we hadn't had the b-bug this morning, we would have gone further into the Brecon Beacons to do a walk today. But actually what I did was get the map out and go 'where can I get to in Blodwen that will give us a nice walk?"

"we've explored much more than we would have done in the car. Definitely. … you're in such a lovely place, you don't necessarily want to take the car all the time"

"Going up to the waterfalls the other evening was a very pleasant experience whereas (in the car), we might not have done that. We would have gone to the more distant ones".

The charge point network also provided inspiration and structure to the b-buggers' day. It gave them a sense of purpose – target destinations where they could enjoy themselves but also enjoy the challenge of getting there.

"We've used 4 charge points … we've hired bikes, taken canoes out, eaten out at the Felinfach Griffin .. all of them have been fantastic"

"after the first day, we started to plan where to go and how to get there"

The key was that the journey by b-bug was part of the whole experience.

"doing the things in Boris just made it quite quirky and different".

"we did some fun things and the journey was part of that fun .. normally, the journey's just functional, isn't it?"

In fact, one couple described how their last day, they had used their car for the first time to reach a more distant tourist attraction but had found it disappointing – much less fun than the previous day when they had failed to reach a nearer attraction because Boris couldn't make the hill!

People also described how it made a much more relaxing holiday experience than using the car.

"I have a very stressful job and I didn't want to be driving miles and miles whilst we were on holiday. I like to chill out and this has been excellent for us"

And it gave them more opportunity to engage with local people which they really enjoyed.

"You generally need to add 10 minutes to most journeys because people stop and chat to you"

7.3 What *didn't* they like – problems and concerns

The triallists talked significantly less about problems or concerns they experienced driving the b-bugs. Obviously this was partly because the triallists were all self-selecting and those who were less keen drove the b-bugs less and thus

encountered less problems[14]. But the lack of operational problems was impressive given that the b-bugs were research prototypes rather than product standard and most of the complaints were about small design problems which would be fixed in a production model. We also had only four call outs during the entire trial where the b-bugs needed rescuing and only two of these were because of an actual fault. In the other two cases, people had failed to charge the b-bug when they thought they had. No-one ran out of range.

Figure 14 shows the problems and concerns which people mentioned. Only 4 were mentioned by more than 4 triallists.

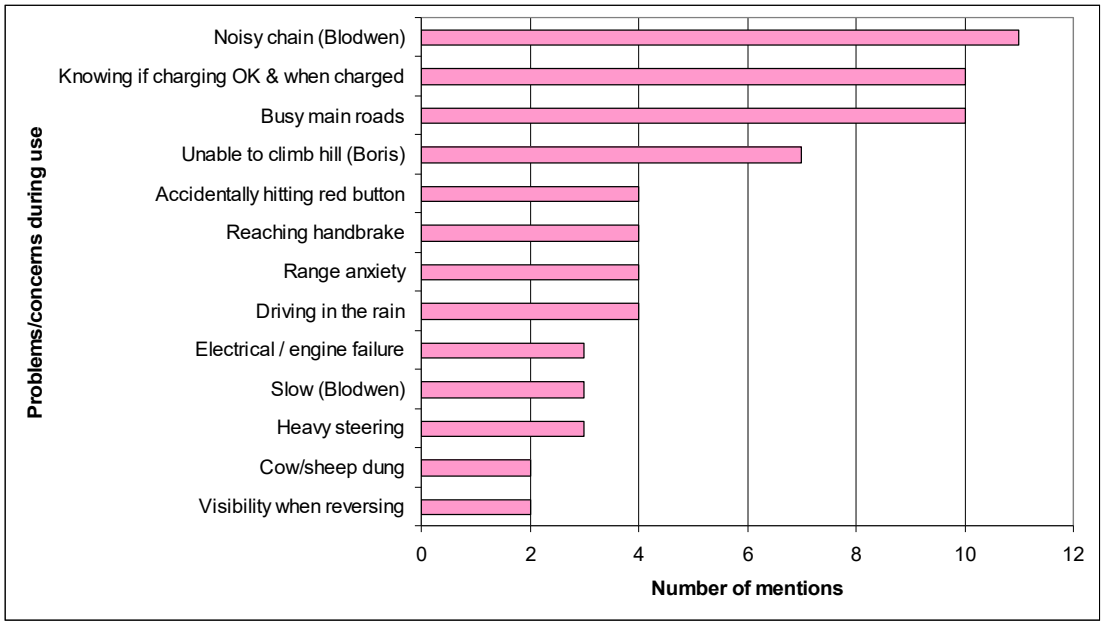


Figure 14 : Problems of using the b-bugs

1. Noisy (Blodwen)

The most frequent complaint was about Blodwen's noise. This was caused by Blodwen having two chains in order to increase her hill climbing ability. Unfortunately, this made it too noisy to carry out a conversation whilst driving.

"Blodwen is too noisy. When you're driving, you struggle to talk to one another".

"Blodwen was noisier than you'd expect"

This was not a problem in Boris.

2. No charging indicator

Unfortunately, the prototype b-bugs had no indicator to show that the batteries were charging or one to show when the batteries were fully charged. Triallists had to rely on rest voltage data from the Cycle Analyst.

[14] For example, one lady didn't realise she had to charge the b-bug at all because "the voltage hasn't yet reached zero" but this didn't cause her any problems because she barely used it. The problem was ours – how to get it back home!

"We were anxious how you know when it's charged and worried might have overcharged it by leaving it on all night"

"I put Blodwen on charge. I was completely mother hen the whole day 'is she charging? is she charging?'"

Unfortunately, sometimes external charge points weren't switched on and also Blodwen occasionally tripped the local circuit's RCD for some reason. Triallists therefore became understandably anxious about whether the b-bugs had charged.

"I would like to have confidence that nothing's tripped out. On old fashioned battery chargers, you used to have a meter. You plug it in and 'boing' it slowly decreases"

"We made a bit of a mistake. When I put the plug into the waterproof box, I caught the switch and I hadn't realised. We got back 2 hours later to the Mountain Centre and we hadn't charged"

This is an easy problem to rectify in a product b-bug.

3. Busy main roads

Sometimes, a b-bug trip involved a short stretch on a busy main road. No-one liked doing this and it was the only time they talked about feeling unsafe.

"The A40 was a bit hairy .. I didn't particularly like that"

"a bit exposed and a little scary on the main roads"

This seemed to be mainly about the relative speed difference on the major roads.

"I'd have felt more comfortable on the A roads at 35mph, 40mph – keep up with traffic a little bit more"

4. Hill failures (Boris)

Boris proved unable to climb really steep hills even at low speed. In most cases, triallists cheerfully coped with this by the passenger getting out and walking!

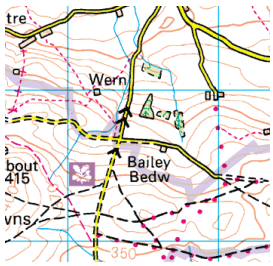
"we didn't realise how steep the back road was back to the village and Boris was crawling along so my husband disembarked and followed at a good pace and he walked off his pudding so that was good!"

"I tried the road coming up to the Farm shop and that was at walking pace. Boris didn't like it at all. In fact, the passenger had to get out.

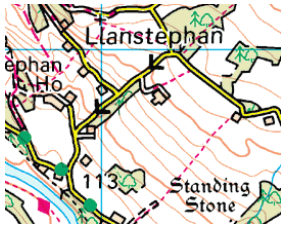
Only one triallist failed to get to their destination because of Boris overheating on a very long steep hill.

"it was such a long hill, Boris didn't die on us, he just overheated and started to smoke"

However, double-chain Blodwen coped fine with even the steepest hills.



"We drove all the way to Glasbury and up to the common. We went up a very steep hill, right to the top – absolutely no problems whatsoever"



"Blodwen did a big hill climb up to Llanstephan church this morning. Coped with beautifully"

The remaining concerns were all mentioned less than 5 times[15]. Given how unpleasant it is to drive a b-bug in the rain, we were surprised people didn't complain about this more often but it seemed that was because they opted not to b-bug at all if it was raining. ("*We woke up the next day and it was absolutely tiddling with rain – so we didn't take it out at all until the evening"*). Those that did try driving in the rain, didn't like it but their main complaint wasn't about getting wet (they were dressed for that) but about how painful the rain was hitting their faces".

"driving in the rain – it hurt my face"

"when raining stings on your face like hail"

"We did our first drive in the rain today. It wasn't raining heavily but it's a very different experience in the rain. That's a given that it is an open vehicle"

Some kind of windshield could prevent this although we found that goggles or a visor worked well.

"when I hit the driving rain on the common, that's when I put the goggles on and I've always used the goggles since and they make a phenomenal difference"

Perhaps because they were so positive about the b-bugs and it wasn't costing them money to hire them, the triallists cheerfully adapted to the b-bugs' limitations.

"if it got very hot, we just stopped and gave it a rest"

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[15] In our experience, this often happens with negative comments. The topics tend to be much more diverse than positive comments – often with only 1 person mentioning any topic.

"Boris wouldn't get up the slope out of the car park and so I jumped out and gave it a gentle push up there"

7.4 When you'd choose a car over a b-bug

Aside from long journeys, the triallists were fairly clear that they would opt for a car over a b-bug in 2 cases. Firstly when it's pouring with rain:-

"On Saturday, Blodwen didn't get used very much because it poured down with rain. I popped into town once in it but it was a pretty horrible day"

"I think rain is one of the key factors as to when you would use the car and not use the buggy. I don't see any other reason"

Secondly, where the journey involved busy main roads.

"we didn't use the b-bug because the Trericket bridge was closed and that would have involved a long drive on the A470 which was very busy at the time"

"I didn't want to go into Brecon because of the main roads"

A couple of people also opted for a car journey if they needed to dress smartly either for work or a social event and the weather was bad.

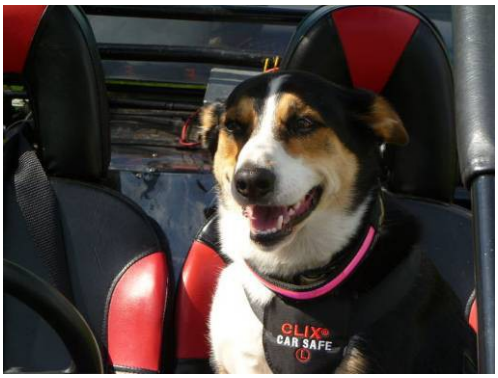
"the need to be smart on arrival in work – not wet and covered in detritus from the trees"

"Saturday night we went to the theatre.. we were going to take Blodwen but I had a dress and heels on and it threatened rain"

Finally, there were occasions where there were too many people or too much luggage to make a journey by b-bug.

"With a young family, having only two seats meant that it drastically reduced what we would use it for"

Passengers in the trial still ranged from octogenarians to small children and dogs!



7.5 Reactions to b-bug speed and range

7.5.1 Speed

Most triallists thought that the top speed of the b-bugs (30 mph) was fine.

"I think 28mph was my top speed and I thought that was plenty"

"I had Blodwen up to 35 coming down a hill but it's easy to sit at 30 mph and to be honest that's fine "

They stressed that on short journeys and on back roads, it didn't seem much slower than using their car.

"around the back roads, this is a much better vehicle to be in"

"we did 20-30mph compared to 40-50mph (in the car). In total time saving, it isn't that much. Also when it's so easy to pull Boris up, just park up and what have you, it doesn't feel as if it takes that great chunk of time out"

The work commuters with short journeys didn't think they lost out on time at all.

"For me it worked brilliantly, I found that the journey time wasn't that different"

"I've only got a mile to go so it doesn't make much difference. You can't really get above 30 on my run to work even in a car"

Because the b-bugs are open and you sit near the ground, people generally perceived the speed as higher than it actually was.

"it terrified me coming down the hill even though I was only doing about 30mph!"

"we shot downhill and I said to my partner 'guess how fast we're going?' She went 'I don't know – 60-70 mph?'. We were doing 28mph!"

"you think you're going so fast until you meet a car and then you realise it's so slow"

A number of visitors and local residents said they appreciated being slowed down as it relaxed them.

"on the way down, I was not as stressed as I usually would be if I was late for something. I sit back, relax and feel a great sense that I do really want my own b-bug"

"it just took your foot off the pedal… you just approach things differently"

"I think if I was commuting for a longer time, it would certainly put a better balance on our personal life which is very frenetic. We're constantly buzzing about everywhere and it's really good to try to slow down a bit"

A few people (all men) said they would prefer a slightly higher top speed for long work commutes and main road driving.

"I'd like a slightly higher top speed on the flat. I think it needs to do at least 35mph.. I found Blodwen a little boring over Boris on the long straight stretches"

"I'd prefer a slightly faster one but you've just got to forward plan, haven't you?"

7.5.2 Range

Both visitors and local residents were reasonably happy with the limitations of a 25 mile range. They certainly didn't find it particularly restrictive.

"I don't think we got hindered much by the 20 mile radius"

"it doesn't feel restricting in the b-bug – it really doesn't at all"

"most journeys are short journeys anyway"

We think this is because most car journeys are actually within b-bug range but also, unlike a car, the b-bug isn't comfortable enough for longer journeys – after 10-15 miles, you are ready to get out and have a break.

However, the fact that the 25 mile range isn't a constant did cause problems and was a major source of anxiety on longer trips ("*We had our hearts in our mouths"*).

Even with a simple battery level indicator (which the b-bugs didn't have), it's still not possible to predict exactly how much range you have left at any point. This unpredictability is the problem rather than the range itself – especially for visitors who were unfamiliar with the routes and where most routes in the National Park involve some hills. Indeed, our own empirical testing of b-bug ranges showed variations of 30% plus depending on driving style, terrain, passenger load, stop/ start manoeuvring and ambient temperature[16].

"Blodwen started to lose power on a hilly and windy route to work, she was slowing up and I only just made it into the office"

"I must admit that I was a bit nervous at that point because I realised that we'd come a long way down and up again"

"we made an evening run to the Felinfach Griffin Inn (7 miles) involving 2 substantial climbs. The return leg was in the dark with the headlights on and with 2 further climbs, we were a little concerned we might be running low on batteries"

The more ambitious triallists (who attempted longer and hillier journeys) quickly learned to make use of the Cycle Analyst readings combined with the graph of rest voltage x miles which we provided (see Figure 1).

[16] It's easy to forget that much the same range variation is true for ordinary petrol cars. The difference is that when you have a large range to start with (~500 miles), then you don't worry about whether the car will actually manage 500 or only 400 miles today. You only start worrying when the tank is empty. Driving a low range electric vehicle is like driving a car on empty all the time!

"the geek in me was looking at the kW usage all the time. The voltage when you're driving is completely useless because it's up and down but it's incredibly useful when you stop. You know you've at least got a reasonable estimate. The graph's fantastic. We used the graph all the time"

"before setting off, we would check (rest voltage). That graph you did in the back is really reassuring and very helpful"

The people who had the least problems were those who learned how to use the dynamic Cycle Analyst data and to adjust their driving (and routes) to conserve power and maximise range – a useful skill for any eco or economically sensitive driver!

"the first day I was driving to the speedometer, days after I was driving to the kilowatts"

"I learned that taking your foot a bit off the pedal, you can actually keep the speed the same but use less power. It was a new experience"

"I'm thinking whenever we are drifting downhill, we're not using any power. Say there's a hill with a hump, I won't actually put any power on because coming down at 20-25mph, it will go over the hump"

The Blodwen triallists were also learning how to deploy the regenerative braking to recover power on any downhill stretch they could.

"coming down, I deliberately kept it regenerating as hard as possible on all the downward bits .. you can get 2.5 going back in"

However, some triallists couldn't be bothered to work out how much power they were using and preferred to 'wing it' based on a rough sense of how far any journey was. This behaviour might be more typical of the wider population.

"I couldn't be bothered (to check the rest voltage) – I just drove economically if I was worried"

"I had a good idea how far the return trip would be and hoped I didn't get lost"

So, although some triallists asked for a b-bug with greater range, it didn't seem that they actually wanted or needed to travel further than 20 miles but rather they wanted to increase the margin for error on such journeys so they didn't have

to worry about range-affecting factors like hills, speed, passenger load and ambient temperature.

7.6 Charging network

Our volunteer charging network of 20 local pubs, cafes, activity centres and attractions worked smoothly and well. 15 out of the 20 were used – two of them quite frequently. These are the aspects which worked well:-

1. **Attractive destinations – structuring the day**

Some of the keener b-bug triallists saw the charge points as attractive target destinations around which to structure their day's activity or choose where to eat.

"so we went to the Mountain Centre and that was really because it looked a nice place to go, we could go walking around but also you could charge up Boris there"

"Tuesday we went canoeing .. to be able to charge up whilst you go and do something different, that's the nice part"

"the first night, went down to Talybont – had lovely fish & chips and met up with Boris as well – so the b-bugs were back to back which was really cool"

2. Good for local business

And that, of course, brought business to these charge points.

"every single one of the charge points has made money out of us"

"if Drovers paid 30p to charge Blodwen, we gave them £37 to hire bikes and we've given Wye Valley Canoes nearly £60 probably and they've charged it 3 times"

"If they are coming up the Mountain Centre well OK they might be going for a walk but there's a good chance they're eating something in the café, they're spending in the gift shop… we are widening our audience by having them up there. They might not have come up there otherwise"

Off canoeing

Shopping and tea

3. Safety net

For visitors, knowing about the b-bug charge points (which were all marked on a map for them) eased their anxiety when making longer journeys,

"we always knew we had the option of stopping in Glasbury and recharging there"

"today we had a fallback plan which was to stop and recharge at the River café"

4. Range extenders

The more ambitious visiting triallists used charge points to extend their range.

"We thought of where we could go to where we'd stay there for a little while for whatever reason, be it a cup of coffee or what have you or visit something - that you could then put some more power in and therefore our radius that we started to look at got wider and wider as the week went on"

"I think if can plan it so you go maybe 1 hour or 2 hours driving, you can stop and plug it in for an hour and then you can go on a little bit further and, if you have to stop again for another hour and plug it in, it doesn't matter"

And one couple actually signed up new charge points en route in order to get to new places!

"we planned the route via Talgarth because we wanted to go to the mill and en route we rang the mill and they were very willing to accommodate us"

"..then I thought 'hang on a minute, we need some more power', there's a British Waterways' office down there, I'll just have a wander down and see … they were very helpful. We charged Boris up. We went for a walk for a couple of hours. There was enough charging to get all the way back"

5. Enjoyed the welcome and hospitality

Visitors remarked on how welcome the charge points had made them feel and how much they enjoyed chatting to them.

"We planned that we'd top up at Crickhowell. They were very good. "oh you've found us, I've just put the kettle on, come and plug it in"

"they were brilliant at the Mountain Centre, they couldn't have been any more helpful"

"the lady at River Cafe really likes Boris – she really does – she came out today to have a chat with us"

7.7 Effect on people's thinking

As mentioned earlier, words to do with thinking and thought were the 3rd most common synonyms as triallists talked about the b-bugs.

Analysing these comments suggest that the experience of driving the b-bugs had the following impact on people's thinking.

1. **They were surprised how easy an electric vehicle was**

Only 1 of the 30 triallists had ever driven an electric vehicle before. Many said that they had expected it to be much more complex to drive and manage.

"I was curious what driving an electric vehicle would be like .. I thought it's going to be a bit of a pain, there's going to be lots of fiddling around but it was easier than running a pushbike!"

"I do think people would use an electric car if they knew it was that easy. I think people think it's a huge hassle.. I've never driven an electric car and I'll consider buying something different next time I change a car given how easy it is"

"I didn't realise they were even feasible as a means of transport"

"plugging in was brilliant – just came in, plugged in, off we go and at home time, unplugged"

2. **They were surprised how many journeys were feasible in a short range, open air vehicle**

"I got around more than I expected to .. went to the Post office several times to pay in cheques, did the shopping, took the recycling to Talgarth twice, went to see someone I needed to see"

"on short journeys, it would replace a car comfortably. So many journeys we make are short and it would be possible to replace many of these with b-bug journeys"

"we are looking right now in investing in another vehicle and we just need one to commute .. it was very interesting to be testing this. It just opened our eyes a little bit to other potential"

3. **It made them think about the relationships between energy and driving and it changed how they drove**

In modern cars, most people are unaware of how much energy is used for acceleration or hill climbing or driving fast. Driving the b-bug got people thinking about energy and focussed their attention on driving style and the terrain. It would be interesting to know if any of this transferred to driving their own cars after the trial.

"I was probably going quicker that first day than I was on any other day because I wasn't thinking quite as much about how much fuel it might be using"

"I was able to modify my driving style to take account of the kilowatts"

"I was becoming familiar with the way you conserve energy – I mean you do freewheel when you go slightly down. I was automatically starting to do that"

"It is funny how quickly you get into the mindset of looking after the charge. You try to challenge yourself to find the flattest route to places and 'where can I get a bit of downhill?' – it's quite fun, I enjoyed that – 'what's the flattest way through Brecon?' If you do that in your own car, you save fuel"

4. They were surprised how little electricity was needed to 'fuel' a b-bug and the how cheap it was to charge

Nearly all the triallists were surprised how little electricity a b-bug needed to cover 25 miles (3 kWh) and therefore how cheap it was to do journeys (<2p/mile).

"it's massively cheaper than running a car"

"Surprised how cheap the cost of recharging was and how easy to top up. If homes had solar panels or other forms of electrical generation effectively the cost is 'free'"

"if you were going to go for 20 miles, you've already saved yourself £5 in petrol"

Although few people factored battery wear and replacement costs into their thinking.

8 The future for b-bugs?

8.1 What is a b-bug and what is it good for?

We asked the triallists to use their experience of the b-bugs to help us think what their future should be.

They were clear that the **b-bug is NOT a car but a fun, cheap and handy way to replace local car journeys.**

"The nice thing about the b-bug is that it's obviously not a car. It's not trying to be a car. It's completely different and that's part of its appeal"

"The psychology I think is really interesting – how you behave differently with it from the car"

"..with the b-bug you know it's short range. ..I had a great time. It's brilliant. ... It is what it is and it's not trying to be anything else"

"you couldn't give up a car to have a b-bug, it would have to be your 2nd vehicle"

"trips to the shops, commuting to work- bridging the gap between short cycleable journeys and longer non-b-buggable journeys"

The triallists thought that the two main applications for the b-bug were local work or shop commuting and holiday hire.

1. Work commuting and shopping runs

The keen trial visitors felt the b-bug would work well for their urban commute back home.

"There are some things that would make this a brilliant commuter car in cities. .. If I was going from the house we live in now to work – it's a 4 mile journey to work – absolutely perfect for this"

"If I found local employment within 5/6 mile radius of home then definitely consider it for spring and summer commute to work. Would also do local shopping trips"

"I could easily use a vehicle like this to go to and from work – 1 mile each way. I use the car at the moment because it's lunchtime. If I watch the clock enough, I can get ready and walk. Most of the time I think 'oh, I've just got two minutes so I'll do that first' and then I have to go in the car"

The local residents found the b-bug worked really well for their (often hilly) commute to work and they would use it instead of the car except in bad weather.

"I would use it to commute every day" (14 miles)

"I'd use a b-bug for getting to work because it's just that bit too far on a bike (15 miles).. and I'd use it for running to Brecon to do my shopping. I can get my weekly shopping in the back"

"If I had Blodwen, I'd use it for commuting - I've only got 1 mile to go – and the short runs about town"

"I commuted back and forth to work (5 miles). I did all the village runs in our village so my mother in law lives at the top village so I did up and down because we go and see her every day"

2. Holiday hire

The triallists would be keen to hire a b-bug in future if they visited the Brecon Beacons again.

""We'd do it again. Definitely. It just made it such a laugh. Much more fun"

"people were always saying 'where did you hire that from?'. I don't think you'd ever have a problem hiring them. So many people approached us and asked"

"You can really see 2 or 3 being based at various campsites and people booking them for the week. People are relaxed and looking for something different – especially with camping"

"Certainly the people that we've spoken to at the centre that have used it think it's fantastic. They can leave their car at their accommodation and use this little thing to buzz around in. They thought it was wonderful. I think that's a really good market for them"

"You turn up here and then you don't use your car for a week – yes!"

Several triallists independently suggested a scheme like the Boris bikes in London might work well for the b-bugs

"I could see that it could really have a use if one was able to get over the logistics of the numbers of them and where they were based – almost like Boris' bikes. One was at each of the main Visitor centres a linked-in system"

"My thought was that you could have a sort of Boris bikes type thing where you have lots of them and people could swipe a card or something and people could pick one up or drop one off. I guess then you could get a bit further"

"If they were at a station like an inverse 'park and ride' – 'arrive and drive'. With simple modifications so you can put a bag on the back and a little bit of cover"

"you need a model where you can just pick them up and go"

Because we couldn't find a feasible way to insure them, we weren't able to charge triallists to use the b-bugs so couldn't test how much people would pay to hire them. When asked, people volunteered a day rate between £30 and £50 and a weekly rate between £100 and £150.

8.2 What characterises b-bug users?

We found that nearly everyone enjoys a one-off b-bug ride, but obviously not everyone would enjoy using one for a longer period or every day.

We found that the keener users (and potential purchasers) included both men and women, aged anywhere between 25 and 65 years but sharing one or more of the following characteristics:-

1. Outdoor enthusiasts

People who enjoy being outdoors in the countryside and are not put off by getting wet or windblown and happily dress for the weather.

So, for example, campers and caravanners made much more use of the b-bugs than those staying in cottages or guesthouses. These people like to be outdoors and dress for the elements.

"if you're camping, the weather is not going to affect you much. You're going to be dressed for that anyway"

"we like doing things, we like canoeing, we like going on boats and things like that"

And the same was true for the commuters (certainly the longer distance ones).

"I've got down jackets that I wasn't wearing that I could have worn on a colder day but so nice to be actually OUT in that beautiful crisp morning – it was lovely"

"I don't care that I get to work and I can't pull a comb through my hair, I had a great time"

"it was great to get suited up in waterproofs and get back in Blodwen! It's a whole personality change"

2. Occasional Cyclists

People who like the idea of cycling but either aren't fit enough to manage hills or don't want to cycle very far.

"ideal for someone who'd like to cycle but is not fit enough – used to the elements"

"I could cycle to work but that would be a real challenge every day. Some days you just don't feel up to that pushing. The last bit is a killer"

"I'd use a b-bug to get to work because it's just that bit too far on a bike"

"I'm not fit enough sadly to cycle up the hill to work and still be presentable for a day's work. And that's where Blodwen came into her own for me. Great I haven't got to use my car and I'm outside"

3. Ex motorcyclists

A number of the keener triallists had driven motorcycles or scooters in the past or even still owned one.

"If you take the view that it's the same as going on a scooter, then your attitude is yes, it is a bit slower and you've got to be prepared for the elements"

"I think being a motorcyclist helped because, being in the fresh air, potentially exposed if it's going to rain or anything like that. It's something you're familiar with and isn't too off-putting"

"we were bikers when we were young so we were quite familiar with the whole outdoors, wind in the hair scenario"

3. Rural Satellite dwellers

The b-bug seemed ideally suited for people living out in the country but only a few miles from the nearest town.

"It's ideally suited to someone who lives out of town a little bit and needs to go in on frequent occasions and can do that on small roads"

"I think short rural runs in and out of town"

"5 mile commute round here – there's no other way of doing it" (than car)

4. Eco-conscious

As we discussed earlier, the triallists talked remarkably little about the environmental advantages of driving a b-bug. However, most of those who opted to take part in the trial said they were "very interested" in environmental issues so were self-selecting in that sense.

"He's got a quad bike at home and he loves all the renewable energy and all that. He's got a turbine and he lives in the middle of nowhere so it was right up his street"

But the b-bugs' main appeal was certainly not the fact that they were green.

"It's fun to drive, it gets you where you want to go and, by the way, it's green"

8.3 Would the triallists buy a b-bug?

This was a trial of a concept prototype but 7 of the 30 triallists (23%) expressed strong interest in buying a product standard b-bug for their own personal use.

"yea, I want to buy one! I do. I want one!"

"I'd have one tomorrow"

"will you be selling them? You'll have a queue out the door"

7 more triallists said that buying such a vehicle was a possibility they would consider.

"with fuel prices rising, I can see the attraction of an alternative source of travel"

We asked the triallists roughly how much they would expect a b-bug to cost. Some had "*no idea*". Others pointed out that it depended what you were comparing it with – a second car, a go-kart or a motor or quad bike.

"would people see it as an alternative to your car or as a fancy go-kart? – that's the way to see the pricing"

"Would it be more economic than a motorbike?"

People's estimates ranged between £3k and £6k with £5k the most frequently cited.

A number of people were thinking in terms of savings they would make in fuel costs whenever they used the b-bug to commute rather than their car.

"I worked out every time I took Blodwen to work and back again I saved myself about £7.50's worth of diesel"

"it costs me £7.00 a day to run back and forth in my car"

"If you can get local authorities parking charges removed for them. You've suddenly got a vehicle that isn't just saving you petrol, it's saving you £30 a week"

8.4 Design suggestions

The triallists suggested a number of design improvements for a product b-bug. The few who had the opportunity to drive both b-bugs liked the hill climbing ability of Blodwen and the feeling of safety which the regenerative braking offered on steep descents. But they much preferred the quieter Boris and also valued his added speed on the flat and downhill.

"I'd rather take Blodwen because of being able to get up all the hills"

"In Blodwen, I was having to accelerate downhill. If you take your foot off, you just grind to a halt" (effect of the regenerative braking)

"If you want to do hills, take Blodwen. If you don't, take Boris"

People particularly appreciated Blodwen's acceleration at junctions which involved a hill start.

The triallists suggested the following other design improvements:-

Windscreen (5 requests)

Quieter (5 requests)

Range indicator (4 requests)

Charging indicator (4 requests)

Lockable storage (4 requests)

Reachable handbrake (!) (4 requests)

Reserve battery (2 requests)

Faster charging (2 requests)

Dragon Electric Vehicles are using the trial feedback to ensure production b-bugs address the main concerns. In particular, Blodwen's chain noise and slower speed

and Boris's poor hill climbing can all be improved by gearing and controller modifications. A battery charging indicator and a battery charge monitor will be incorporated which will obviously help users estimate and manage range estimations and anxiety. Other small faults (e.g. positioning of the handbrake) have already been rectified.

9 Conclusions

The trial successfully achieved its aims.

The b-bugs inspired visitors to leave their cars behind and travel around the Brecon Beacons in a different and more enjoyable way. And they chose to do this **because it was fun rather than because it was green**. The effect was that they chose activities, days out and places to eat which were local (within 5-10 miles) using their cars much less (or even not at all) during their stay. This was in direct contrast to our previous findings where visitors travelled an average of 50 miles by car a day often leaving the National Park completely.

Driving the b-bugs got people thinking and talking about energy, driving styles and terrain – factors disguised by the use of modern cars. They started to drive differently in ways which would reduce fuel consumption in any vehicle. The b-bug experience also opened their eyes to electric vehicles as a realistic option for them.

The trial showed people can happily adapt to a low energy, low speed, restricted range, open vehicle for many short rural journeys – **as long as the experience is enjoyable**. The 25 mile range and 30 mph speed was fine for most holiday visitor journeys as well as for local commuters. Fortuitously, the b-bug goes about as fast and as far as is comfortable for most people given its rugged and open air nature. Any pressure to increase the range was to relieve anxiety caused by its unpredictability rather than the need or desire to make longer b-bug trips.

The triallists didn't perceive the b-bug as a car and its "non-carness" (funky, rugged, open-air) was an essential part of its appeal. They saw it as a fun alternative for local journeys.

People coped with the open air nature of the b-bugs – indeed this was one of their major attractions. However, most people would avoid using them in heavy rain and opt for the car instead. They also didn't like driving the b-bugs on busy main roads but fortunately the need for this was rare.

The informal charging network of pubs, cafes and activity centres worked well – it provided free and easy top up charging plus a set of attractive destinations (and associated activities) for the visitors. Meanwhile, the charge points gained additional business from these trips.

Although people appreciated the clean, green aspect of the b-bugs, this was seen as a pleasing 'by-the-way' by most triallists rather than the main reason for using them. Visitors opted to b-bug because it was outdoors, different and fun and turned ordinary journeys into enjoyable adventures. Local commuters opted to b-bug because it was fun, handy and cheap and nice to be in the open air.

The idea of 'rain-powered' electric buggies captured the media's attention and the b-bugs featured on BBC Wales news, Yahoo travel and Green Car website and were mentioned in The Guardian, Western Mail, London Metro, Daily Mirror, The Independent, Countryfile Magazine, Waitrose Magazine and Camping and

Caravanning Magazine. Most recently, the b-bugs were listed in the Guardian Green Travel List of the top 25 innovative green tourism initiatives for 2011.[17]

9.1 Our recommendations

The Prospectory, who initiated and conducted the b-bug trial, is a consumer and eco-technology research company. It will not be manufacturing or hiring b-bugs itself.

Based on the trial results, there is the following potential:-

1. Availability of b-bugs (or similar fun, green vehicles) could dramatically change visitor travel patterns within the National Park in ways which are:-
   - good for the environment,
   - keep tourist activity and revenue local,
   - give the Park a promotional edge as an eco-tourist destination.

The key is making the transport a fun part of the holiday experience.

2. There is clear potential for a b-bug rental business within the National Park if a solution can be found to insuring such vehicles for hire (and at reasonable cost[18]). At the moment, we know of no such solution. This could help expand the fledgling 'Electric Wales' concept [19]being developed by Drovers Cycles in Hay on Wye with electric bicycle hire. Growing this concept again would help give Wales a distinctive edge as an eco-tourist destination.

3. A charging network to support top-up charging of low-energy electric vehicles is free and easy to set up and evolve. As destinations, they add interest to the holiday and there is a clear, commercial incentive for the businesses involved. The amounts of electricity involved are small.

(It will be a while before there are significant numbers of electric cars which can make the long journey to rural Wales. High speed charge points with industrial power supply are needed for higher end vehicles which need quick recharging on major trunk routes to enable these long journeys[20]. For the time being, electric vehicles which reside and only travel within the Brecon Beacons can make use of a free, informal network of regular 13 amp sockets and this can evolve as the number of visiting electric vehicles increases).

4. There is a potential consumer market in rural Wales for a b-bug style 'not-car' – i.e. open, low-energy, cheap, low speed and range. 90% of commuting journeys in Wales are less than 25 miles and many rural residents live only 5 miles from the nearest town where they shop or work but have no viable public transport option and it's too hilly to cycle. The cost of fuel in rural areas is also significantly higher than elsewhere. A 25 mph b-bug can, we understand, be driven legally by 16 year olds and holders of provisional driving licences.

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[17] http://www.greentraveller.co.uk/green-list

[18] Customised policies are possible but prohibitively expensive.

[19] http://www.droverholidays.co.uk/electricwales.html

[20] Rapid charging of this kind *does* involve significant amounts of electricity and so there would have to be a significant compensating commercial exchange to subsidise the cost or a direct payment.

Electric micro-cars like the Renault Twizy[21] are clearly intending to address a similar market opportunity. Initially they are targeted at city-dwellers in terms of their design, supply chain and servicing and they certainly offer city dwellers an attractive proposition. It would be interesting to explore their potential appeal and utility for the rural commuter market – maybe with a slightly more rugged design.

Disruptive technology (for example, electric cars) can struggle if it cannot compete at the outset along the dimensions of value established by the incumbent technology[22]. So, for example, electric cars might be rejected by many because they can't travel as far or as fast as normal cars and take hours, rather than minutes, to 're-fuel'. Successful disruptive technologies have historically succeeded by establishing themselves in markets where they have an advantage over the incumbent. Perhaps b-bugs and micro-cars (like the Twizy) can gain an early foothold *because they aren't trying to compete on range or speed* – they can target short journeys where they are highly effective, easy to park, cheap and fun.

However, this means 'not-cars' *have* to be cheap because they can't replace someone's long distance car. For b-bugs to do this, they would have to be manufactured in large enough numbers to bring the price down to the £4-5k range. Could there be a way of doing this in Wales?

Our companion technical report discusses what the design/performance parameters might be for a b-bug style product.

5. Finally, there is a view that to change people's behaviour, you have to change their attitudes. That is tough to do and rarely effective. The b-bug trial shows the opposite in action, i.e. changing people's behaviour by offering them something interesting and fun to do. This disrupts habits and stimulates new thinking and new behaviour. People on holiday are relaxed, have time and the mindset to try different things. That creates an opportunity.

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[21] http://www.green-car-guide.com/electric-renault-twizy.html

[22] See 'The Innovator's Dilemma' by Clayton Christensson http://web.mit.edu/6.933/www/Fall2000/teradyne/clay.html

[23] http://www.dragonelectricsportscars.co.uk/

tale, and told us all about it afterwards. We hope they had as much fun as we did running the trial.

Blodwen resting after climbing up into the hills above Talgarth (July 2011)