RiDC

Energy Monitoring of Assistive Technology

energy saving trust

Contents

About RiDC

RiDC is the leading expert in inclusive research involving disabled consumers. We are an independent, national charity with over 50 years of experience in consumer research and insight in this specialist area.

It's the only type of research we do.

We are run by, and for, people with a personal experience of disability.

We always start from the perspective of disabled and older consumers.

By working with disabled and older people, listening to their needs and reflecting on their experiences, we make sure nobody is excluded, and the insights we gather are grounded in real life.

RiDC was one of the first organisations to establish a UK panel of disabled and older consumers. Our panel includes over 4,000 people and is the most extensive pan-disability panel in the UK.

Executive summary

This is an exploratory piece of research aiming to quantify the energy consumption of assistive technology, at a device level.

This research consists of:

- Survey
- Initial focus groups
- Preliminary interviews
- Energy monitoring field work
- Follow up focus groups

The research comprises a report and consumer guidance, published on the RiDC website (www.ridc.org.uk). Following this, there will be a stakeholder event in Autumn 2023 to implement the findings into action plans.

Main findings

1. Many participants saw value in quantifying the amount of energy used at a device level. Some felt this would be beneficial on a personal level, emphasising the importance of informed choice when purchasing/choosing assistive technology.

2. Based on our research measuring the energy consumption of assistive technology, we provided initial data in this area as a basis for future research. When taken across ten participants, measuring either two or three pieces of assistive technology, the average cost per year to run the equipment was £50.88. This is an average calculation using a price estimate by the Energy Savings Trust[1] based on a standard rate in England, Scotland and Wales.

    Whilst the exact cost will vary depending on individual circumstances, the average calculation is not negligible and requires attention.

[1] How do we calculate our energy saving data? (energysavingtrust.org.uk) Data retrieved on 26th October 2023. Data for England, Scotland and Wales from 1st October 2023 and for Northern Ireland 1st July 2023

3. Overall, using energy monitors felt relatively accessible for people with varying access needs. The remote-control function of the energy monitors indirectly had a particularly positive effect on the day to day lives of many of the participants when using their assistive technology.

4. Although measuring the energy consumption of assistive technology was helpful on a personal level for some participants, disabled consumers simply cannot reduce the usage of this vital equipment itself. The focus needs to be on improving the energy efficiency of these technologies as well as financial support provision. Ultimately, the running of assistive technology is vital for health, wellbeing and day to day basic human needs.

5. The majority were in agreement that further wide scale participatory research of this nature is important for:

   a) Raising awareness of the extra energy incurred by disabled consumers to help advocate for grants to help with rising energy costs.

   b) Having more data to compare the energy efficiency of assistive technology. This would support both the public and private sectors in providing more in depth, person-centred information to assistive technology users. Particularly when purchasing/choosing new assistive technology.

Main Recommendations

1. Provide grants to support families who rely on assistive technology.
2. Ensure information on financial support is both available and accessible. Ensure consistency with Web Content Accessibility Guidelines (WCAG 2.2).
3. Ensure app development is consistent with Web Content Accessibility Guidelines (WCAG 2.2).
4. Provide more assistive technology running cost information, both in the public and private sectors. This is either to inform purchases of new technologies or to support decisions when receiving new pieces of equipment.

5. Increase availability of consumer information in relation to the energy monitoring of assistive technology. Specifically, tailored as much as possible to individual access needs.
6. Consider distributing energy monitors to families with assistive technology in the home, to support them with making informed choices.
7. Conduct further research providing a large-scale comparison of the energy consumption of assistive technologies. Allowing for a detailed comparison of:
   a) Manufacturers
   b) Energy suppliers
   c) Renewable energy alternatives in the home
      With the aim of improving the energy efficiency of assistive technology in the wider sense, including medical equipment and hardwired technologies.
8. An industry standard for the energy efficiency of assistive technology.

Background

This research study is part of a broader RiDC research programme investigating whether disabled and older consumers can easily access and use low carbon energy products and services. The research programme **Enabling Inclusive Innovation and Sustainable Choice** is funded by the Energy Savings Trust under the Energy Redress Scheme Round 11 (Innovation). The programme is being led by RiDC and delivered in partnership with the Energy Systems Catapult (Living Lab).

Participatory Research

This research was initiated with a survey which was distributed to RiDC panel members on 28th October 2022, receiving 750 responses. The role of this survey was to hear from our panel to help develop the next stages of this participatory design project.

This then informed the design of three focus groups. These aimed to gain insight into three key areas identified from the survey outputs:

1. Energy use of assistive technology
2. Energy use in the kitchen
3. Media campaigns and behaviour change

Participants were recruited from the initial survey responses. We included participants with varying accessibility needs. Broadly speaking, recruitment included participants with cognitive, physical, and sensory impairments.

During this session, we investigated participants' current knowledge of their energy usage from their assistive technology. The majority of participants did not know how much energy their assistive technology used and where they did, it was an overall knowledge of energy consumption in the home rather than device level knowledge. For example, from using a smart meter as opposed to an understanding of energy usage for an individual piece of assistive technology.

This knowledge led to the findings from the rest of this report. This is strand one of two research strands:

'Participatory design research investigating energy use of assistive technology in the home.'

The other strand is being reported separately:

'Investigating disabled people's engagement with low-carbon energy options and advice.'

Figure 1. Participatory research flow
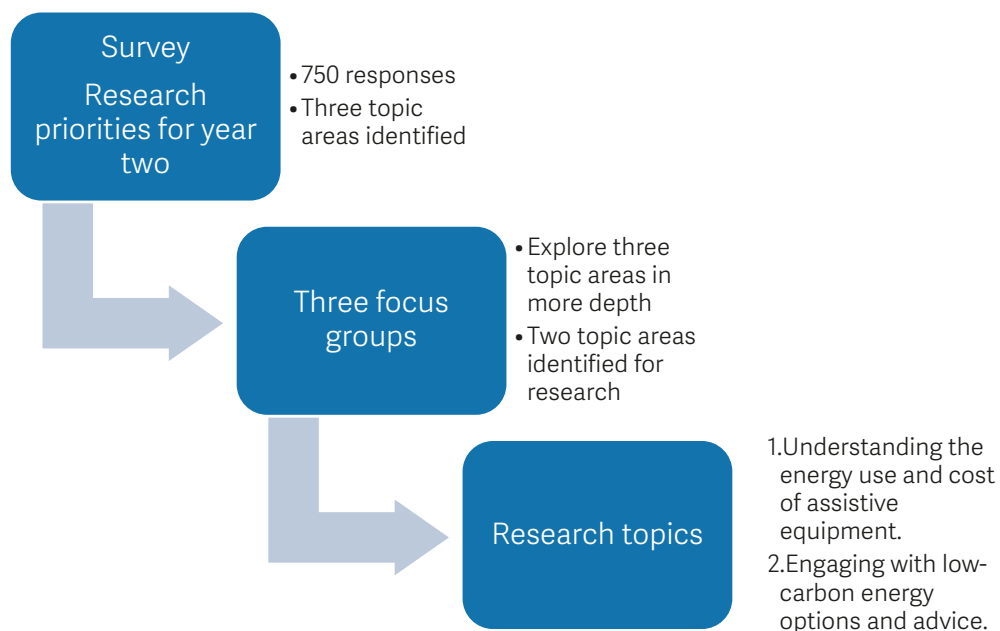
Research Questions

The primary research question was:

1. What is the thirty-day energy consumption of individual pieces of assistive technology?

The secondary questions were:

2. What can be done to support assistive technology users with energy consumption in the home?
3. What are the benefits of people knowing the energy consumption of their assistive technology, in terms of purchasing/choosing new pieces of equipment?
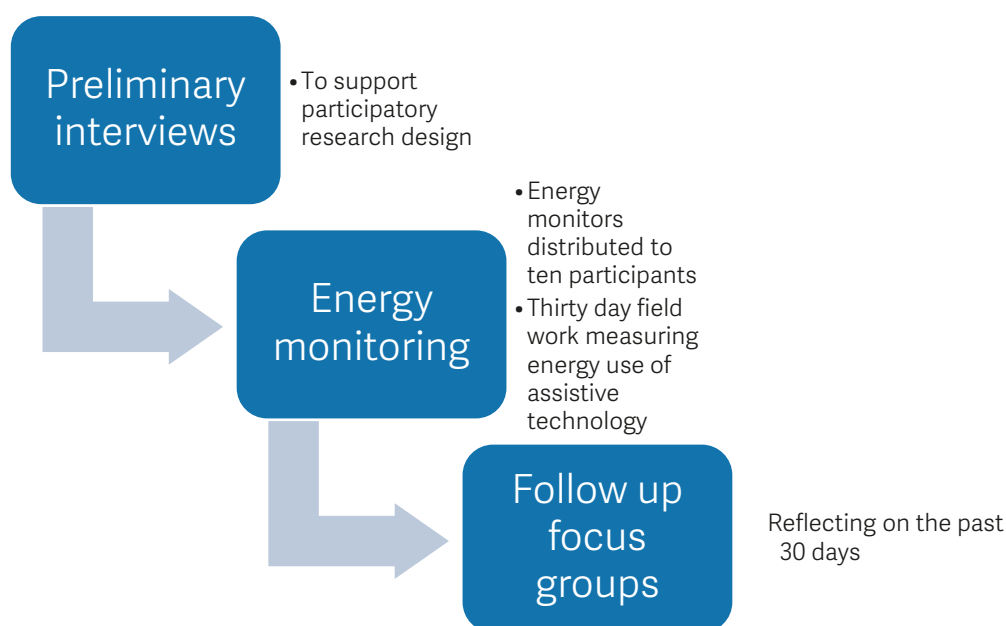
The research aims were:

1. Raising awareness of the extra energy incurred, purely as a result of having assistive technology in the home.
2. As a basis for potential in depth future research, comparing the energy efficiency of various types of assistive technology.

Methodology

The research was conducted over three stages (see figure 2). It included preliminary interviews, energy monitoring and follow up focus groups.

Figure 2. Energy monitoring research flow

Preliminary interviews
- To support participatory research design

Energy monitoring
- Energy monitors distributed to ten participants
- Thirty day field work measuring energy use of assistive technology

Follow up focus groups

Reflecting on the past 30 days

Preliminary Interviews

Following the initial focus groups, informing the research design of the main project, interviews were carried out with participants recruited for the next stage of the research. These were carried out to gain feedback on the design of the next stages.

Participants

Participants were recruited based on having at least two pieces of assistive technology in their homes. However, the majority had three or more pieces of equipment, including one having approximately twenty-seven pieces of equipment in their home.

We included participants with varying accessibility needs. See **Appendix 1, Table 1.**

Pseudonyms are used throughout this report.

Procedure

The interviews took place over Zoom or Teams, depending on participant needs and preferences. One telephone interview was conducted.

The interviews were semi-structured in nature. The topic guide focused on addressing both the practicalities of the main research project as well as the individual and wider benefits of conducting the research.

Energy Monitoring

Participants

Ten participants were then selected to measure the energy use of their assistive technology. Nine were participants who had already taken part in the preliminary interviews.

We included participants with varying accessibility needs. See **Appendix 1, Table 2.**

Materials

Nine out of ten participants used a Kasa Smart Plug to measure the energy use of their assistive technology. The model used was the KP115 and the manufacturer was TP-Link. This required installation of an app to a smart phone. One participant was provided with an alternative energy monitor without an app to ensure inclusivity. This energy monitor was from URBZUE, manufactured by Ningbo Cowell Electronics & Technology Co., Ltd. The model is PMB05-UK.

Once participants had received their energy monitors, they were provided with a login attached to an RiDC email account which had been previously created by an RiDC Researcher.

An RiDC Researcher was available to support with setup where needed.

Procedure

Participants were sent an instruction sheet at the start of the project to enable setup.

They were asked to choose up to three pieces of assistive technology to measure. A point raised in the preliminary interviews was the difficulty in defining 'assistive technology'. Whilst we wanted this to be as open as possible, we asked participants to choose the equipment most vital for their health and wellbeing. We did face some difficulty navigating the blurred line between assistive technology and medical equipment. Therefore, were careful to exclude equipment that could cause immediate ill health if switched off for a short period of time as this would be considered to be medical equipment. However, the energy use of medical equipment would be a vital piece of research for the future, with an appropriate risk assessment.

The types of assistive technology included within this research were electric wheelchairs, adjustable beds, airflow mattresses, rise and recliner chairs, electrics fans, a scooter and an electric door.

Once participants had received their monitors, an RiDC Researcher scheduled a ten-minute call to support with setup. The Researcher needed to be available to verify the Kasa accounts at the start of the project.

Once setup, depending on participant needs, data was collected by either:

1. Participants sending weekly screenshots of energy readings to the RiDC Researcher
2. The Researcher logging in to the Kasa account whilst the participants were on the phone.

These weekly readings were taken to keep participants engaged and to allow for participant attrition rates.

On day thirty, an RiDC Researcher logged into the accounts to access the final readings.

Participants were provided with an £150 thank you payment for their contributions.

Follow up Focus Groups

Following completion of the energy monitoring project, we carried out two further focus groups to reflect on the past thirty days of energy monitoring.

The focus groups were broadly split into three sections:

1. Reviewing the accessibility of the energy monitors themselves.
2. Reflections on the energy monitoring data.
3. Next steps and resources for change.

Participants

Eight participants took part across the two focus groups. One participant was provided with a phone interview as an alternative. These were all participants who had taken part in the ongoing thirty-day project. Participant details are included in **Appendix 1, Table 3**.

Procedure

The focus groups took place remotely over Zoom. They lasted approximately ninety minutes with a short comfort break in-between. Participants were provided with a further £50 thank you payment for their participation.

These focus groups were semi-structured in nature.

Results

Key findings

Preliminary Interviews

From conducting the interviews, there was a clear consensus that the energy monitoring project was important to both quantify and bring awareness to the extra energy used by having assistive technology.

"It's going to give people with a disability… more information than what there is out there. Because at the moment, there is very little information out there in regards to energy output for assistive technology". – **Ben, visual, dexterity & mobility**

"It definitely needs to be looked at because I am sure there are ways that things can be made to be less expensive to run". – **Jane, dexterity, hearing cognitive & mobility**

"It sounds like a really interesting project actually, it's probably long overdue. And I guess with high energy costs for everybody, people with disabilities are going to always, always pay more than somebody who doesn't have a disability… it will be good to see the results". – **Jane, dexterity, hearing, cognitive & mobility**

Some felt this would be beneficial to them on a personal level. However, overall, the extent to which participants felt they could change their energy use was limited. Many felt they would not be able to minimise charging assistive technology and emphasised the vital importance of this equipment for their health and wellbeing.

"It might be an argument for using with my energy provider about whether I am on…certain packages or not. Help lobby the government to take account of that… because **we have no choice**, I can't not have them plugged in… So, it's a cost that I have to meet". – **Rose, dexterity, cognitive & mobility**

"I guess it would be interesting to understand how… much energy things use. Whether or not it would actually affect us. We just kind of have the sort of thinking that it is what it is. My daughter has to go upstairs, we have to use the stairlift… **we don't really have a lot of choice** about whether we use the things or not irrespective of how much they cost". – **Jane, dexterity, hearing cognitive & mobility**

The majority were in agreement that this research is important for raising awareness of the extra energy used by assistive technology users to help advocate for more government grants and funding to help with rising energy costs. Some also felt a direct comparison of the energy consumption of assistive technology to compare models and manufacturers would be beneficial to them personally.

If providers could give an estimate of the energy used for each piece of equipment, this would provide consumers with the ability to make informed choices when purchasing or choosing new equipment.

"More broadly, I think it is very beneficial because one, it gives more evidence for… things like more support from the government and more pressure for energy companies to do something about it. But also for like the device manufacturers themselves, it's more pressure for them to really think about energy efficiency and energy usage". – **Poppy, dexterity, mobility, visual & cognitive.**

"I have OTs coming in and saying... 'We need to get you this equipment or we need to get you that equipment', by knowing what the energy is... my equipment that I have already got isn't taking that much power, I can have that extra equipment. But then if it's like what I've got already is taking too much power, do I really need that? **It will help me I think making future decisions** on what equipment I need and what equipment I don't". –
Ben, visual, dexterity & mobility

Energy Monitoring

It is important to note that our participants measured up to three pieces of assistive technology. However, the majority had at least three pieces of equipment with many having far more. One participant confirmed that they had approximately twenty-seven pieces of equipment.

It is also important to emphasise, that we could not measure hardwired assistive technology such as ceiling track hoists.

The average statistics are therefore intended as a basis for future research with a wider sample, including all necessary assistive technology and medical equipment in the home.

Further, the results have been calculated as an average, they do not reflect the individual circumstances of our participants. They are not intended to provide disabled consumers with an exact cost estimate.

When taken across ten participants measuring either two or three pieces of assistive technology, the average energy usage after thirty days was approximately 15.5 kWh.

In terms of cost, this would equal to about £4.24 per month and £50.88 per year. It is important to note, that this is based on an estimate by the Energy Savings Trust[2] based on a standard rate in England, Scotland and Wales.

In Northern Ireland, this estimate would be approximately £2.54 per month and £30.48 per year.

It is important to consider that this is an extra cost incurred solely due to having a disability. Perhaps, more concerning, in one case an airflow mattress consumed 41.5 kwh of energy during the thirty-day period. Based on the aforementioned standard rate in England, Scotland and Wales and bearing in mind individual differences to energy bills, that could cost £11.35 per month and an astonishing £136.20 a year. This is for just one piece of assistive technology. This participant confirmed they have approximately twenty-seven pieces of equipment in their home.

Whilst important to interpret this finding in its context, it does highlight a need for more attention in this area. Perhaps, more so than ever due to the rise in the cost of living affecting so many individuals to various extents.

Follow up Focus Groups

The aim of the follow up focus groups was twofold. The first focus being on the experiences of using the energy monitor itself, considering the accessibility of the process. And the second, being a chance to reflect on the data collected over the previous thirty days. The focus groups ended on a short section highlighting next steps/future actions.

Accessibility of energy monitor and app

Information finding

One participant made an interesting point that despite the experience being incredibly useful to them, they would not have thought to purchase a

[2]How do we calculate our energy saving data? (energysavingtrust.org.uk)
Data retrieved on 26th October 2023. Data for England, Scotland and Wales from 1st October 2023 and for Northern Ireland 1st July 2023

monitor, if it weren't for this project. Specifically, because they would have not known where to look to purchase it in the first place:

"For me, it was very accessible. I guess it felt a bit daunting before I did it, you know, to start with. Like, I think if I'd not had like your kind of like guidelines and, you know, knew that I could, like, get advice, I might not have started it in the first place. Because I think, **the unaccessible bit is like finding the plug, you know, going on Amazon yourself and like reading through like all the information** and finding out what you need". – **Poppy, dexterity, mobility, visual & cognitive.**

"If someone had just said to me like, oh, well, you can monitor your energy usage by buying like smart plugs. I'd just be like eugh, like that sounds like a faff… So, **it is accessible but sometimes there's a pre step to that** isn't there… like getting people to understand that it's actually very accessible". - **Poppy, dexterity, mobility, visual & cognitive.**

Plug setup

The main difficulties encountered throughout the process were plugging the monitor into the socket in the first place. This was due to plug sockets being in hard-to-reach places, particularly for wheelchair users and those with poor dexterity. It was also highlighted that the monitors were quite clunky, making it harder to fit behind assistive technology such as an adjustable bed:

"It depends where you're going to put it. One of the reasons I didn't use my bed was for the same reason…I couldn't get to it. So that's why we used the power chairs. I guess there's a lot of things that you need. Like where it's going to go, how you are going to plug it in". – **Jane, dexterity, hearing cognitive & mobility**

"My sort of house plugs aren't really set up for me in a wheelchair because I wasn't in a wheelchair when I moved into the house…The items I wanted to monitor, they're in behind beds and down at floor level and things like that". – **Rose, dexterity, cognitive & mobility**

Energy monitoring, remote function

However, once setup, many were very complementary of the app. The remote function on the app was particularly beneficial for participants to control their assistive technology:

"I liked the option where you could turn the plug on and off… if I was to kind of put the plug in a hard to reach place, which one of my plug sockets was under my bed. And I didn't want that plug on during the day, then you would be able to turn it off…on the app. So that was quite handy. And the other thing was the energy part of it, where I could go in at any time and I could kind of see what it was using there and then…So, it was an eye opener to, kind of see." – **Ben, visual, dexterity & mobility**

"I'm actually going to buy some more of the plugs and use them because I think they're really good and they're, they're worthwhile having a timer because it saves you going and actually switching the appliance off because you can do it from your phone rather than trying to get to the plug and bend down and switch it off… I think they are very, very good… And much easier to use than the original ones that come out when you used to have to imput the price of the… the kilowatt hour and everything. I found those very difficult to use. But these

are really easy". – **Judith, dexterity, visual, hearing, cognitive & mobility**

One participant even highlighted that having this remote function actually reduced their need for support from carers for certain tasks:

"It was an interesting experience for me because it actually made me, like, really think about what else I could do, like going forward, like with smart technology… we're going to buy some… Alexas off Amazon…And because we were like, oh, like we could like, you know… control like this and our… bedrooms and I found it a real novelty thing being able to turn the fan on and off myself. In fact, on one occasion I called my carer like in to do it. And then I was like, 'Oh no, you can go away again now'… So for me…it is actually quite like a eye opening experiment". – **Poppy, dexterity, mobility, visual & cognitive.**

Energy Monitoring, app accessibility

One participant highlighted the ease of setting up the monitor to their Google Home and the benefits of this:

"I didn't dislike anything really. I think it had quite a good bit of information on it and also, you can put it on to your Google home as well, which I thought was really easy. You can just connect them to that so you can use different things all with one app… if you forgot to charge a chair or something and you're in bed, you can just click the button on it because everyone has the phones with them all the time. I just thought it was really easy to use". – **Paul, dexterity, visual & mobility**

Another participant confirmed the app was helpful to them as a visual learner:

> "I did like the app. I like that with each of the devices that you had, you could add a picture to it because I kind of, **I'm quite a visual sort of person. So, it helped to have a picture** beside which one it was, which was either my power chair or my daughter's one". – **Jane, dexterity, hearing cognitive & mobility**

Generally, participants confirmed the text size within the app was sufficient, except for a tool bar at the bottom being too small. However, this was generally overcome by the ability to zoom in to the app using a smartphone.

> "I did actually find... the bit at the bottom of the app. I don't know if it's the same with all devices where you've got scheduled timer, away and energy, the four choices at the bottom, **I did find the font really, really small and I don't have the best eyesight.** So, I did struggle...first of all, but once I realised that it was the fourth one along the last one for the energy one, then that, that was fine".
> **– Jane, dexterity, hearing cognitive & mobility**

However, no one found any accessibility settings, within the app itself:

> "I did look for like, whether it was possible to like increase font size and stuff like that **I didn't find...any kind of like accessibility features**, but I may have missed it." – **Poppy, dexterity, mobility, visual & cognitive**

Further, one participant using screen reading software, confirmed this app wasn't compatible:

"There's a software that I mainly use and it works with most apps and it will like sort of kind of make the text bigger and stuff like that. For some reason with this app, it had issues and it kept on coming up with errors. So when they built the app, they must have put something there and it basically **blocks any kind of, accessibility readers** or anything for it and you can't do it. It just comes up with error messages". – **Ben, visual, dexterity & mobility**

Energy monitoring, data

A participant highlighted that when compared to a previous energy monitor they had used, the ability to store the data within the app was helpful:

"In terms of energy monitoring, was nowhere near as good. It just sort of told you what it was using at that particular time, which is not really that much use. I mean, **this one is nice because you've got, you know, how much your daily consumption is… your weekly and your monthly**". – **Brian, dexterity, visual, hearing & mobility**

Reflections

Some found the task of energy monitoring a helpful experience, leading to them feeling a sense of control to be able to make positive small changes to their energy consumption.

"I mean, like the scooter, I found out that it was still using electricity all the time. So, I think what I will do in future is leave the plug on it, but switch it off after I think it takes about 8 to 10 hours to, to charge. And then I would switch it off, **put it on the timer to switch off because I can't see the point of having that trickle**

charge all the time. The batteries… they are good enough to hold the charge". – **Judith, dexterity, visual, hearing, cognitive & mobility**

When reflecting on the data, a key finding was that many participants felt the pieces of assistive technology that they expected to use more energy, actually used less and vice versa. They confirmed that further research involving direct comparisons of assistive technology and their energy consumption would be highly beneficial to make informed choices when purchasing assistive technology in the future. One participant found that her daughter's wheelchair used less energy than hers, which was unexpected. Finding out cost implications would be beneficial for future purchases.

Many confirmed that information availability and accessibility is key:

"I think it's quite important that when we get these new wheelchairs, I always kind of say to them: 'Well, what's the power consumption?' And they all go, 'Oh, I don't know.' And they don't really give it to us. And I kind of feel that **as a company, they should be kind of aware and they should be monitoring this themselves…**there might be people out there who do struggle paying their electric bill. And you're just now saying, 'oh, you've got to now charge it every night.' That's a big difference. So, if they were able to say 'Well, actually you could get away with charging it every other day', then it wouldn't save a massive deal, but each pence kind of adds up… I think…different companies should kind of really like take action on that". – **Ben, visual, dexterity & mobility**

"My energy company I say are pretty **good at sending out kind of generic information** about how you can reduce costs **but not maybe specifically around assistive technology or like disability related kind of**

> expenditure". – **Poppy, dexterity, mobility, visual & cognitive**

> "There are lots of variables. Being disabled is expensive in so many ways. We are lucky in a way that our power chairs, beds, stairlift have been provided via grants and NHS provision. But it does mean we are limited on which item we get…I think industry in general should give information on how much energy devices use". – **Jane, dexterity, hearing, cognitive & mobility**

> "I mean that maybe is a question for suppliers to, you know, or installers to give you an idea of what its consumption is… such and such a kilowatt use or a cost use as part of the process of installing them". – **Rose, dexterity, cognitive & mobility**

Emphasis on essential equipment

However, ultimately, whilst the energy monitoring process was illuminating for many, participants emphasised the lack of control to make changes to their own energy consumption. Whilst some felt they were able to make small changes such as switching certain technologies off when not in use, the overall consensus was that assistive technology is vital to the health, wellbeing and basic quality of life for people. The technology itself cannot be used less and the individual changes that can be made when saving energy are often times minimal. Therefore, the importance of finding ways to improve the energy efficiency and consumption of these technologies, rather than their use is imperative here.

Therefore, the onus ought to be on the relevant stakeholders to both improve energy efficiency and funding in relation to their assistive technology:

"The technology that is around that I use... maintains my independence... if I didn't have my BiPAP machine for example, I wouldn't be here". **– Denise, dexterity, visual, mobility & cognitive**

"We do try now and turn the beds off and the mattresses off when we're not using them. But, on the whole, I think it's really difficult...So, **I don't think there's a whole lot we could change.** I mean, maybe I, I guess as like a, a wider sort of thing to look at would be working with, you know, providers. A lot of our equipment comes from the Red Cross, working with the NHS... We're about to get new ventilators. And yeah, we were given a choice between two options. So obviously like power consumption was quite big and part of that decision". **– Poppy, dexterity, mobility, visual & cognitive**

"**You've got no choice.** You can't, you can't say no, I'm not going to use my wheelchair for that day or...you know, use my profiling bed. You just can't do it. Or I'm not going to keep my medication at the right temperature... you know, you have to do what you have to do". **– Paul, dexterity, visual & mobility**

"**You can't not charge these things up...** So, you would have to look at other things. But I don't think the other things that run in my house would particularly, you know, compensate for the amount that the charging, is taken up by the essentials. And I mean, heating would be an essential that I have to have as well or, or it affects my health. So, you're back to the small appliances and chargers... and they're not going to make a difference, really." **– Rose, dexterity, cognitive & mobility**

Many participants also emphasised the importance of taking into account the energy usage for hardwired equipment in the home:

"Some of the things that I think are actually **probably the highest energy usage in our home are not things that were measurable. For example…hoists and lifts and we have, like, wash dry toilets. These things are all hardwired** into, … the main frame of the house…We run power banks as well because like, we're dependent on ventilation overnight. And a few other things that are like, really important for us medically. Not only are we like having to keep things charged all the time, but we're also…charging power banks to have backup, charge, backup energy as well". – **Poppy, dexterity, mobility, visual & cognitive**

Discussion

Overall, many participants found the process of energy monitoring beneficial to them. This was often indirectly due to the remote controls within the app, supporting them with day-to-day tasks such as switching assistive technology on/off. There were many examples where the participants shared that they were now going to purchase more plugs to use at home. Many also felt that having more of these energy monitors would support them with making informed choices when purchasing/choosing and running assistive technology.

It is therefore important to emphasise the importance of companies ensuring that both the monitors and accompanying apps are as accessible as possible, ensuring consistency with Web Content Accessibility Guidelines (WCAG 2.2).

Not only is the accessibility of the app itself important but also the availability of consumer information out there to support people with reducing energy costs in the home. The information available, is often not specific enough or relevant to the needs of disabled consumers.

Generalised media campaigns, showing ways a household can reduce their energy consumption by taking small actions such as turning household appliances off when not in use can be a cause for frustration. This can be for many reasons, not limited to but including, not being able to reach the switches to turn off the appliance easily due to reduced mobility or dexterity.

Many participants highlighted the importance of equipment suppliers, both in the private and public sector, providing more detailed information about the energy efficiency of assistive technology at the outset. This would enable consumers to make informed choices when purchasing or choosing assistive equipment. Just as importantly, is ensuring appropriate person-centred advice is given at the outset, to ensure no unnecessary costs are being incurred to the individual.

More research in this area, involving large scale, direct comparisons of the energy consumption of assistive technology would allow for industry to develop technologies with renewable, efficient and cost-effective pieces of equipment. Whilst accounting for the increase in funding, to support households with assistive technology.

Most significantly, it must be emphasised that assistive technology is of vital importance to the health, wellbeing and basic quality of life for people. The technology itself cannot be used less and the individual changes that can be made when saving energy are often minimal. Therefore, the importance of finding ways to improve the energy efficiency and consumption of these technologies, rather than their use is imperative here.

This research highlights the vital importance of funding to support with rising energy costs. Any extra costs incurred are purely as a result of having assistive technology in the home. This is simply not a choice and should be interpreted in such a way.

Practicalities

Frequently mentioned in the preliminary interviews was the difficulty in defining assistive technology. It is important to consider that many key pieces of technology are hardwired and much more difficult to measure.

Many participants felt their hardwired assistive technology, including but not limited to lifts and hoists, would use the most electricity. It is therefore important to consider that the average values calculated would be higher if these pieces of equipment could be included. This could be a key direction for future research.

There are also many household appliances that disabled consumers rely on, that may not be considered assistive technology but that are essential for health. For example, heating or a phone being used as a screen reader.

It is also important to note that being an exploratory piece of research, participants measured up to three pieces of equipment. However, many had far more than this, with one participant having approximately twenty-

seven pieces of equipment. This suggests that the averages may be significantly higher than this report indicates.

A wider scale, longitudinal study involving assistive and medical equipment would be beneficial for future research.

It is also important to consider the impact of power cuts. Two participants confirmed during the interview stage that one of their main concerns were not so much to do with how much energy is used but with power cuts preventing them from using their assistive technology in the first place.

The seriousness of this issue was highlighted during the energy monitoring stage of the project when a participant apologised that their figures may not reflect the total energy used due to having a power cut that week.

Whilst out of the scope of the current project, this highlights the importance of further research into this area, with a particular focus on the workings of the Priority Services Register.

Achieving change

Future actions

From our research, we have identified future actions for the relevant stakeholders. During our workshops, these will be turned into specific action plans:

1. Provide grants to support families who rely on assistive technology.
2. Ensure information on financial support is both available and accessible. Ensure consistency with Web Content Accessibility Guidelines (WCAG 2.2).
3. Ensure app development is consistent with Web Content Accessibility Guidelines (WCAG 2.2).
4. Provide more assistive technology running cost information, both in the public and private sectors. This is either to inform purchases of new technologies or to support decisions when receiving new pieces of equipment.
5. Increase availability of consumer information in relation to the energy monitoring of assistive technology. Specifically, tailored as much as possible to individual access needs.
6. Consider distributing energy monitors to families with assistive technology in the home, to support them with making informed choices.
7. Conduct further research providing a large scale comparison of the energy consumption of assistive technologies. Allowing for a detailed comparison of:
d) Manufacturers
e) Energy suppliers
f) Renewable energy alternatives in the home

With the aim of improving the energy efficiency of assistive technology in the wider sense, including medical equipment and hardwired technologies.

8. An industry standard for the energy efficiency of assistive technology

Appendix 1. Participant details

Table 1 Interview participants

Impairment	Number	Details
Mobility	10	Paraplegia, Ehlers-Danlos syndrome, muscular dystrophy, peripheral muscular atrophy, hemiplegia, spinal muscular atrophy, multiple sclerosis.
Visual	5	Partially sighted, registered blind (hemianopsia)
Hearing	4	Hard of hearing
Cognitive	7	Autism spectrum disorder, cerebral palsy, memory, epileptic seizures, mental health (depression and anxiety).
Dexterity	9	Arthritis

Table 2 Energy Monitoring participants

Group	Number	Details
Mobility	10	Paraplegia, Ehlers-Danlos syndrome, muscular dystrophy, peripheral muscular atrophy, hemiplegia, spinal muscular atrophy, multiple sclerosis, systematic vasculitis with psoriatic spondyl arthritis & fracture point osteoporosis.
Visual	6	Partially sighted, registered blind (hemianopsia)
Hearing	4	Hard of hearing
Cognitive	6	Autism spectrum disorder, memory, mental health (depression and anxiety).
Dexterity	9	Arthritis

Table 3. Energy Monitoring reflections focus group and interview participants (2 sessions)

Group	Number	Details
Mobility	9	Paraplegia, Ehlers-Danlos syndrome, muscular dystrophy, peripheral muscular atrophy, hemiplegia, spinal muscular atrophy, multiple sclerosis, systematic vasculitis with psoriatic spondyl arthritis & fracture point osteoporosis.
Visual	6	Partially sighted, registered blind (hemianopsia)
Hearing	3	Hard of hearing
Cognitive	5	Autism spectrum disorder, memory, mental health (depression and anxiety).
Dexterity	8	Arthritis

Appendix 2. Energy Monitoring Data

Table 1. 30 Day Total Energy Consumption and Total Runtime

Participant number	Assistive Technology	30 Day Energy Consumption /Daily Average (kWh)	Total Runtime/ Daily Average (Hours)
1	Pressure relief mattress	4.98 (0.17)	711 (23.7)
1	Profiling bed	0.06 (0.00)	711 (23.7)
2	Mobility scooter	4.13 (0.14)	585 (19.5)
2	Riser chair	0.06 (0.00)	696 (23.2)
2	Fan	9.32 (0.31)	699 (23.3)
3	Electric fan	5.93 (0.20)	637 (21.2)

3	Airflow mattress	41.5 (1.38)	704 (23.5)
3	Electric wheelchair charger	5.47 (0.18)	704 (23.5)
4	Profiling bed	2.04 (0.07)	696 (23.2)
4	Electric wheelchair charger	6.31 (0.21)	697 (23.2)
4	Electric rise and recliner chair	0.70 (0.02)	715 (23.8)
5	Profiling bed	2.69 (0.09)	696 (23.2)
5	Recliner chair	0.74 (0.02)	696 (23.2)
5	Wheelchair charger	6.04 (0.20)	662 (22.1)
6	Powerchair	9.06 (0.30)	704 (23.5)

6	Powerchair	6.67 (0.22)	631 (21)
6	Profiling bed	3.86 (0.13)	696 (23.2)
7	Air flow mattress	0.83 (0.03)	696 (23.2)
7	Electric door	4.68 (0.16)	696 (23.2)
7	Wheelchair	6.20 (0.21)	710 (23.7)
8	Air mattress	4.16 (0.14)	711 (23.7)
8	Hospital bed	0.50 (0.02)	696 (23.2)
8	Wheelchair charger	7.14 (0.24)	638 (21.3)
9	Powerchair	3.95 (0.13)	696 (23.2)
9	Powerchair	7.10 (0.24)	705 (23.5)

10*alternative monitor	Mobility scooter	1.90
10*alternative monitor	Rise and recliner chair	8.90

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