

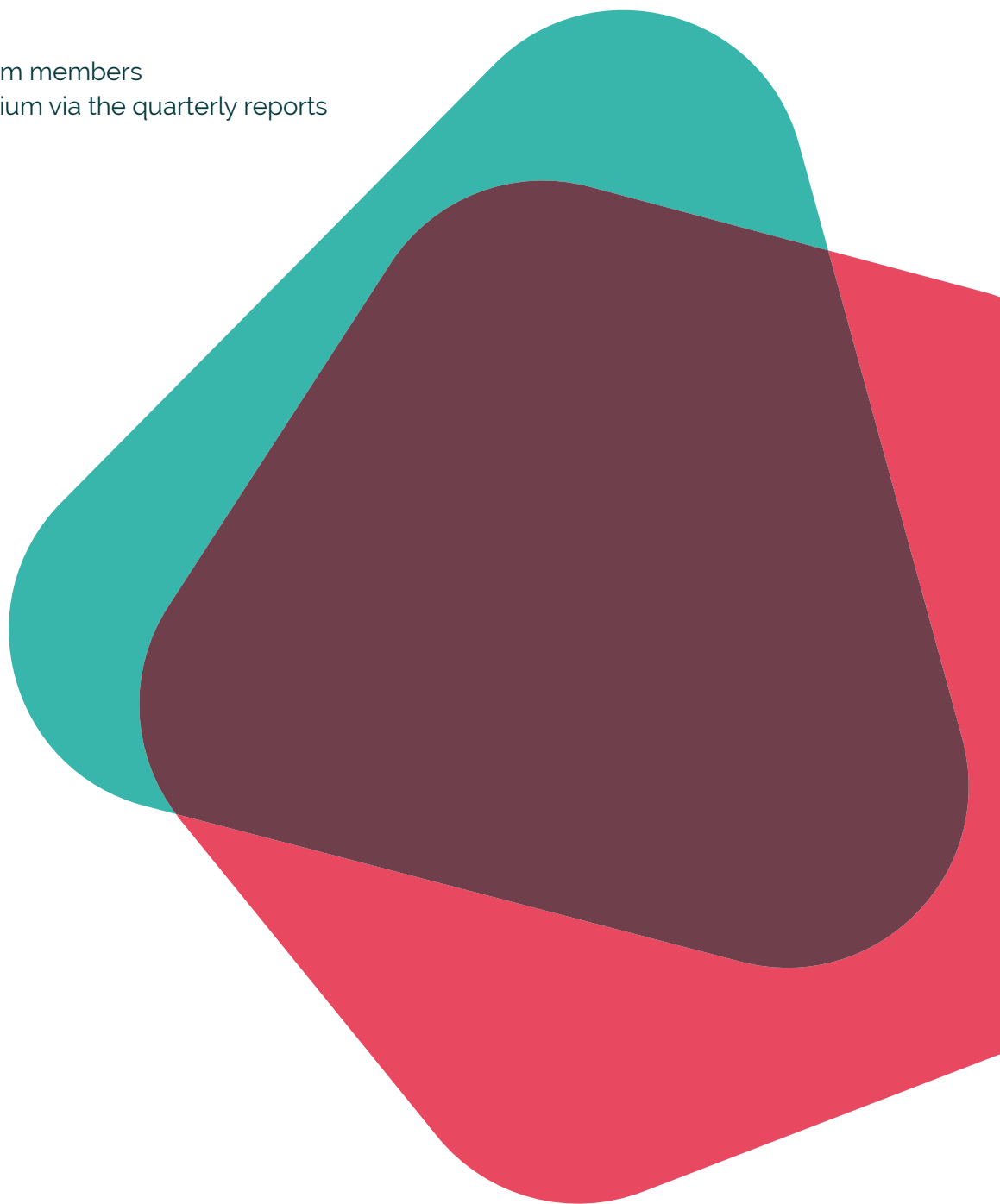


CREDS Annual Report: October 2019 to September 2020

November 2020

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With contributions from members
of the CREDS consortium via the quarterly reports



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1. Introduction

The Centre for Research into Energy Demand Solutions (CREDS) was established as part of the UKRI Energy Programme in April 2018 and has been running for 2.5 years, with funding of £19.5M over 5 years from EPSRC and ESRC. Its mission is to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable, low carbon energy system. We are now a team of over 140 people based in 24 UK organisations.

The aims of the Centre are:

- to develop and deliver internationally leading research, focused on energy demand;
- to secure impact for UK energy demand research in businesses and policymaking; and
- to champion the importance of energy demand.

This is CREDS' second annual report covering the period from October 2019 to September 2020. The [first annual report](#) was published in November 2019.

2. CREDS governance, management and knowledge exchange

2.1 Governance and management of CREDS

The governance and management systems of the Centre continue to evolve. The Collaboration Agreement between the 15 universities that were part of the original proposal has been maintained, and additional universities have been added as *Accession* partners to accommodate the two new challenges and the eight projects that resulted from the ECR Flexible Fund call. We now have 24 universities in the consortium. The Advisory Board that includes stakeholders from industry, policy and academia meets twice a year (November 2019 and March 2020), and continues to provide valuable guidance and approve new funding. The Executive Committee (consisting of the Director, Centre Manager and Theme and Challenge leaders) has continued to meet every six weeks (including one face-to-face meeting every quarter up until March 2020, and wholly online since then).

The CREDS Core Team is based in Oxford, and consists of the Director, the Centre Manager, three Knowledge Exchange Managers, a Government Affairs Manager, a Web and Communications Manager, a Designer, two Centre Administrators and a Data Manager. Some of these posts are part-time. We recruited four new staff members for the core team during the year – a Knowledge Exchange manager for Business (Aimee Eeles), a Government Affairs Manager (Peter Mallaburn), a Designer (Stephanie Ferguson) and a Data Manager (Kenan Direk, UCL, partly with the core team working on data management planning, and partly in the Buildings theme as a researcher).

The Data Manager provides support to all themes to attain a consistent and best-practice approach to research data management, and encourages all projects to have a data management plan (DMP). We have developed a CREDS Data Management (DM) guidance document and are using [DMP online](#). Training and capacity building for researchers on DM was provided at the 6th CREDS Whole Centre Meeting in June and at a joint webinar with the UK Data Service in July.

Individual support has now been provided to 19 researchers and project managers, and 29 projects have a DMP, while eight are in progress. Further plans are being developed, for example, a metadata capture method and an online technical user group.

We welcomed the first international visitors between January and March: more details can be found within the theme sections that are hosting the visitors – Theme 5 on Flexibility and Theme 6 on Policy. We were planning release a further call for international visitors, but this is on hold due to the COVID-19 pandemic.

The Centre has an active working group to develop and implement a plan for Equality, Diversity and Inclusion (see [Section 4](#)).

We communicate regularly with the consortium, with 17 internal newsletters (Consortium Updates) during the period. We have hosted two Whole Centre Meetings (WCM) of all staff in the consortium: in December (WCM5) in Oxford, and in June (WCM6) online via Zoom. Event reports are available on request. The Advisory Board are invited to all WCMs in addition to the whole consortium. We also held webinars for the consortium on how to manage and store data in CREDS and Delivering successful impact (& monitoring it) in CREDS. The latter provided a spreadsheet template for staff to record impact.

The two new themes funded last year on Fuel and Transport Poverty and on Decarbonising the Steel Industry are underway, and are represented in the structure in Figure 1. More details of their work can be found in [Section 3.8](#) and [Section 3.9](#).

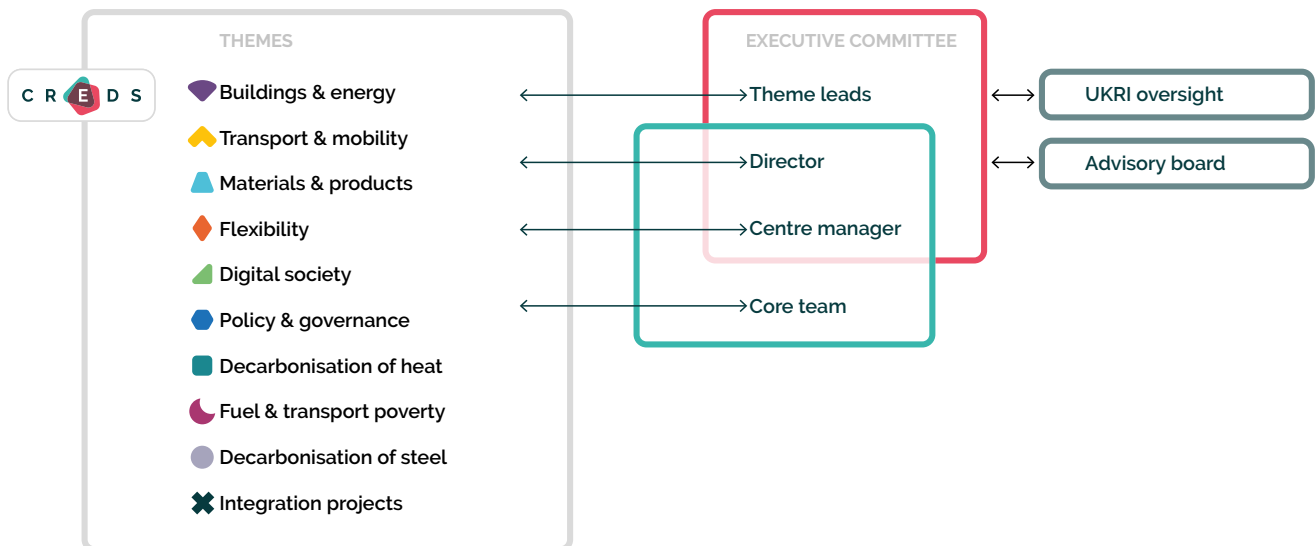


Figure 1: Organisational structure of CREDS.

2.2 Cross-theme activities

Cross-theme activity has been encouraged and is successful, through both the WCMS and by working together on projects. This sub-section only covers work between the different themes: core team work on engagement and knowledge exchange is overarching across all of the consortium and is described in [Section 2.3](#). Examples include:

- Staff from Theme 3 Materials and Theme 2 Transport worked together on the high-profile consumption options paper.
- A forthcoming book – Research Handbook on Energy & Society (Edward Elgar Publishing) brings together contributions from all areas of Theme 6 Policy, as well as contributions from the Transport theme.
- There is collaboration between Theme 6 Policy and Theme 5 Digital Society on business model innovation for local energy systems.
- Theme 8 (Fuel and Transport Poverty) and the Theme 2 Transports' Excess project have had several meetings during 2020 to identify synergies.
- Our response to a recent call for evidence energy-related products involved an external consultant and the core team, as well as staff from the buildings, policy and flexibility themes.

2.3 Engagement and knowledge exchange

Engagement with UKRI included twice-yearly meetings and regular emails, along with sharing big news stories and our Communications and Engagement Plan for 2020. The plan reviews the progress of the 2019 strategy, and also sets out our plan for 2020.

Engagement and championing of energy demand has been a major part of our work this year – Nick Eyre, Jillian Anable, Sally Cairns and John Barrett gave evidence to the Climate Assembly UK, members of CREDS sit on ISO standards Technical Committees, staff have given extensive presentations to expert panels, local Citizens' Assemblies, schools, local authorities and the Energy Systems Catapult. There are also many examples within the theme sections showcasing our engagement with the public, business and policy audiences.

We have developed strong links with relevant Government departments and other key parts of the public sector (for example, BEIS, MHCLG, Treasury, DfT, CCC, Scottish Government, Transport Scotland, Ofgem, and MPs, Association for Decentralised Energy, UK Green Building Council, France's High Council on Climate). These links allow us to contribute directly to policymaking, providing expert advice, facilitating cross-departmental discussions, championing energy demand, and providing a rapid response to immediate needs. For example, we responded to direct requests from BEIS on both the lessons from condensing boiler market transformation and the scope for increasing household energy efficiency retrofit.

We began a collaboration bringing together senior officials from BEIS and MGCLG, with the aim of moving from a reactive to a proactive, strategic relationship that will be more impactful. CREDS has made presentations to Ministers on retrofitting homes, just energy policy, and decarbonising transport.

We launched a number of policy briefing notes, the first on the potential carbon savings from e-bikes which we released to the national and trade media. The story was picked up by the BBC with coverage on national radio, regional media and online cycling sites. We provided two briefings for HM Treasury, Policy for energy demand reduction and Vulnerability to fuel and transport poverty. Green Alliance launched its policy-facing report Balancing the Energy Equation, based on CREDS' research in Shifting the Focus, that was further promoted with a series of blog articles. Finally, CREDS collaborated on a series of seven briefing notes on decarbonising transport for the Local Government Association (LGA) to assist local councils who have declared a climate emergency. During the year we have submitted six consultation responses.

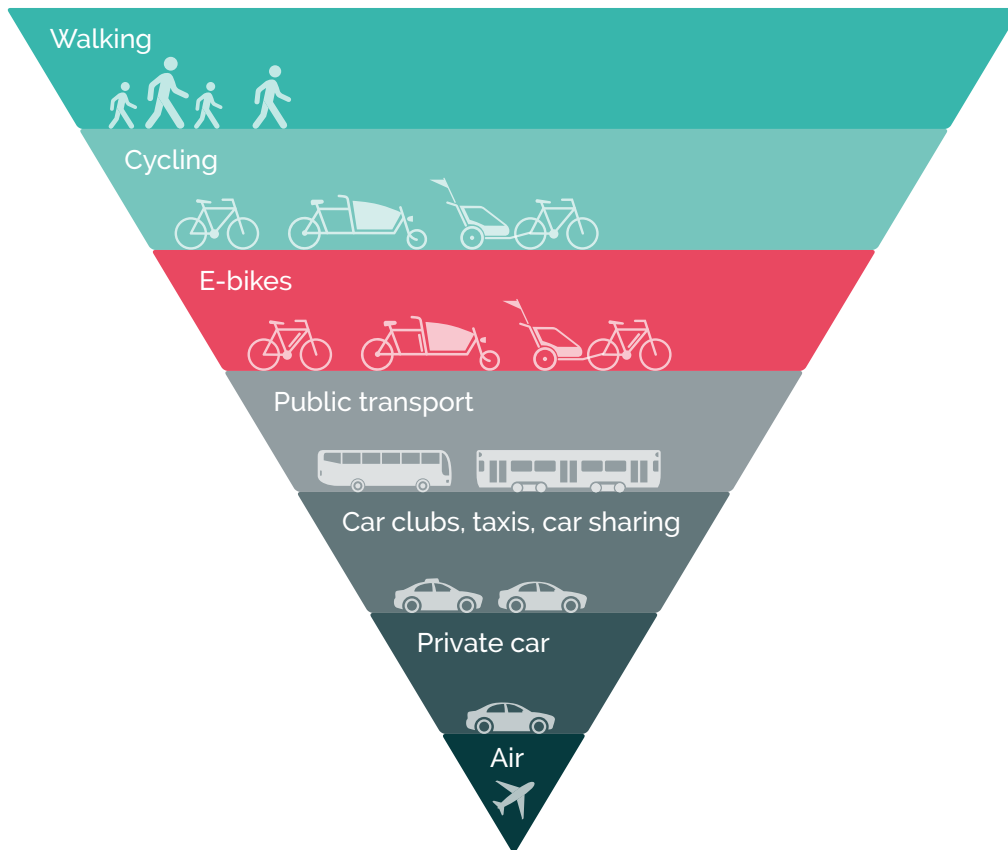


Figure 2: Diagram from the e-bikes briefing showing the most energy-efficient transport methods.

In our role as facilitators of the Energy Demand Research Network (EDRN), we held an event in April on 'How might Energy Demand Research respond to the Climate Emergency?' It brought together researchers from both academia and the third sector who work at different timescales and different levels of detail to discuss how our research might have greater real-world impact, and to learn from each other.

Speakers from CREDS, CAST, Oxfam and Citizens Advice joined us. Over 70 people attended, including overseas participants and resulted in very positive feedback.

We ran a series of webinars including: How to influence the 6th Carbon Budget, Demand-side Flexibility: Beyond price and technology, Energy efficiency in a post lockdown world: Earthshot not moonshot in conjunction with [Integrate](#) (Oxford Martin Programme on Integrating Renewable Energy) and Policy and impact: how does research make a difference? Webinars will run regularly from now on.

2.4 Website and digital marketing

The website has been running for two years, and contains extensive content and regular new material. Some high profile content has featured on the BBC ([Top 10 tips for reducing carbon footprint](#) – based on [Ivanova et.al.](#)) and USA news reports ([Ending the daily work commute may not cut energy usage as much as one might hope](#) based on [Hook et.al.](#)).

During this year we had 26,971 unique users – 10k more than last year. There are two evident peaks in traffic during the year:

- 14 December, 620 users, where 81% of visitors landed on the homepage primarily through direct acquisition (62%) but also 32% referral (high for a referral rate). The BBC was the referral link. This seems to be driven from the BBC around the time of the election.
- 20 May, 670 users driven to the site for the popular blog article on the [best ways to change consumption and cut your carbon footprint](#).



Figure 3: Webstats for www.creds.ac.uk, October 2019 to September 2020.

The most frequently visited pages of the website are the homepage; what is energy demand page; the people page, and the popular [Challenging consumption to cut carbon footprints research](#) news piece. The ECR Flexible Fund call announcement was also very popular, with the e-bikes briefing featuring as the 7th most popular article throughout the year, attracting over 2k unique views.

In addition, two blog articles made it into the top 20 most popular pages of the year: [A new green shovel blog article](#) – 14th most popular page, with over 1000 unique page views and [Ending the daily commute blog article](#) – 15th most popular page, with 846 unique page views.

The most downloaded content during this time period was the [Flexible fund call](#) in November (709 times). The [Shifting the focus publications page](#) remains very popular (11th most popular page) with 1,234 unique visitors during this period, and a further 552 downloads of the full report (total downloads to date 2,652). The [shared mobility report](#) was downloaded 517 times, with the accompanying standalone infographic downloaded 163 times. The [e-bikes briefing](#) has been downloaded 283 times.

Digital marketing includes the external newsletter and social media activities – Twitter and LinkedIn. Four external newsletters have been distributed this year (one every quarter). There are now 613 subscribers to the CREDS newsletter (up by 165 from last year). We have 1,500 Twitter followers (up by 629 from last year) and a steady increase in followers since our Twitter feed was created in 2018. We gained 171 followers in May alone, compared to an average of about 40 per month. The top tweet featured the [Challenging consumption to cut carbon footprints](#) news release and earned 44.1K impressions, was liked 177 times and retweeted 119 times – much higher than previous high-performing tweets.

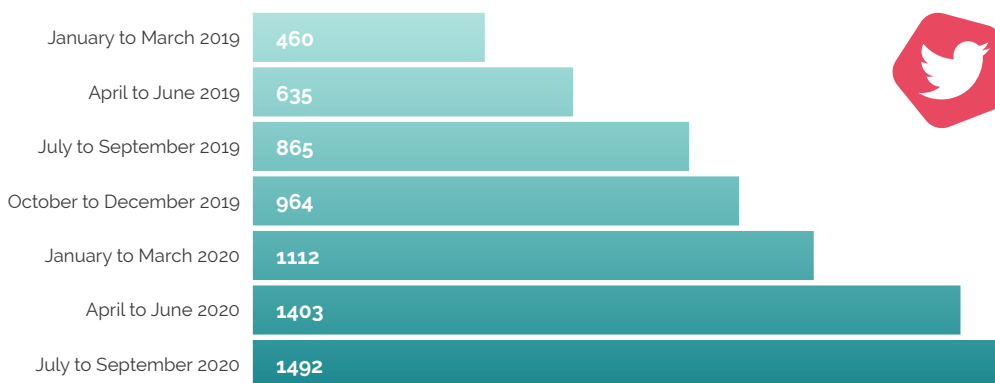


Figure 3: CREDS Twitter followers from the start of the project to September 2020.

3. Research progress

During this period, CREDS staff have authored over 90 publications – these outputs are available on request.

3.1 Buildings

In the Health and energy efficiency project we are working on evaluating health status and energy performance of housing now that access to secure data during lockdown has been resolved. Some researchers have shifted their time onto COVID-19-specific tasks (see [Section 2](#)), so some elements of sub-projects have been postponed or combined. New research in the sub-project on the performance gap can now be undertaken thanks to additional income from the BEIS-funded SMETER project. The buildings team has produced a paper on the incorporation of solar gains into dynamic thermal models and brought together a compilation of novel data sets and algorithm development to produce digitally generated in-use building efficiency certificates.

The London version of 3Dstock London Building Stock Model (LSBM) was launched by the Greater London Authority (GLA), leading to broad media coverage. LSBM is being used by the GLA and London boroughs to identify poorly performing dwellings and non-domestic buildings, and it supports London boroughs in enforcing Minimum Energy Efficiency Standard (MEES).

The 3Dstock model has been developed further, including a journal paper and animation, plus the modelling of properties across Sheffield. 3Dstock is also being used with metered data to provide BEIS with insights into the impact EPCs have on a buildings' energy use.

The theme has made considerable policy impact, including advice to government about the future of the transition to low carbon energy use through reports, consultation, and meetings with a range of senior government officials and Ministers, for example, Social Market Foundation (SMF) and Scottish Power roundtable, "addressing the challenges and trade-offs from the decarbonisation of home heat" where the audience included Keith Anderson, Chief Executive of Scottish Power and Rt Hon Kwasi Kwarteng MP, BEIS Minister.

Researcher George Bennett has been seconded part-time to the BEIS Building Research Team in the Science and Innovation for Climate and Energy (SICE) Department, from January 2020 to March 2021. He will provide technical and policy support in the areas of heating and hot water systems performance, future clean heat strategies and new evidence planning.

We have continued to make an impact internationally, with the launch of the Global Roadmap for Buildings and Construction, co-authored by UCL with the International Energy Agency (IEA) and the UN Environment Programme in July 2020. The Lancet Countdown on Health & Climate Change 2019 Report was launched in London, in November. We were also involved in a webinar workshop titled Global ABC Regional Roadmap for Buildings and Construction in Latin America, run by the Costa Rica Green Building Council.

A variety of proposals linked to CREDS work have been submitted, including using 3DStock as the basis for the EPSRC Centre to Centre call. We also submitted a modified proposal to a new Innovate UK call. It plans to use 3DStock to support the development of a detailed design of a smart local energy system (SLES) in collaboration with Camden Council and an energy service company.

Two new projects have been added to the buildings theme, funded from the ECR Flexible Fund call

- **How can compact combi hybrids (heat pump/boilers) contribute to decarbonising and reducing heat demand?**

The project began in August 2020 and is now finalising a Non-Disclosure Agreement and Data Sharing Agreement with Worcester Bosch. Worcester Bosch are providing the key dataset of diagnostic data from 50k+ boilers in the UK. The project will investigate whether the Compact Combination (CoCo) Hybrid technology that combines a gas boiler and an air source heat pump (ASHP) in one wall-mounted, compact appliance offers a potentially attractive transition technology that can bridge the gap between the current technology of gas boilers and a future dominated by high-efficiency, low carbon heating.

- **DeViz (Defect visualisation via thermography)**

DeViz uses thermal imaging as a behaviour-change tool for informing, empowering, and engaging site supervisors to help them achieve zero defects in their buildings, and so encourage a learning loop and zero-defect culture. In parallel, the project will develop a methodology to enable autonomous checking by construction supervisors using thermal imaging cameras, monitoring their own work, identifying build defects as the build or retrofit happens, and rectifying them much earlier in the construction process.

3.2 Transport and Mobility

Work is now underway on all six projects under this theme, resulting in many blog articles, briefings and papers. Although there have been some delays in fieldwork and recruitment due to COVID-19, the pandemic has also brought a considerable additional workstream involving a large-scale primary data collection effort to investigate the effect of COVID-19 on travel and socialising adaptability (see [Section 5](#)).

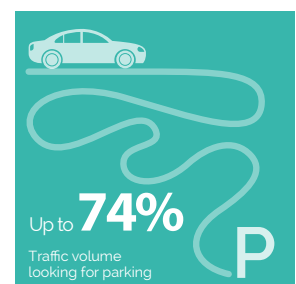
The project on High-End Consumers (Excess) is conducting online one-to-one interviews and online deliberative workshops. Recruitment of high-end consumers (who are both difficult to define and notoriously difficult to reach) is more challenging online, but we are saving on travel costs. A book chapter on Social divisions in energy consumption in the transport sector: personal car ownership and use has been approved for the Research Handbook on Energy and Society (see [Section 3.6](#), Policy). A policy briefing note on 'excess' concepts and spatial analysis has been drafted. A paper on Trends in air travel inequality in the UK: from the few to the many? has been submitted. and links have been made with the new FAIR project (Theme 8) looking at transport poverty. The outputs were fed into the project on modelling flexibility over time, mode and place to explore the relationships between socioeconomic, geographic and built environment variables and car ownership. Work on fairness and tackling 'excess' travel and energy demand was used to provide advice to the UK Climate Citizens Assembly and the Greater Cambridge Citizen's Assembly.

The Commission on Travel Demand has postponed the planned work on leisure travel to 2022, and instead the next inquiry will be a synthesis of work on travel adaptations due to the pandemic. The transport team are now holding monthly evidence exchanges with Transport Scotland, Transport for the North, Strathclyde Passenger Transport, Liverpool City Region Combined Authority, Transport for Greater Manchester, Highways England, Department for Transport, and Transport for London.

The transport team has completed high-profile policy-facing work for the Local Government Association (LGA) with a series of [seven briefing notes on decarbonising transport](#) (covering ambitious action plans, buses, climate smart parking, electric vehicles, growing cycle use, online opportunities and accessibility). They provide practical guidance to councils that are developing strategies to address the climate emergency.

Work to assess of the potential for e-bikes to substitute for car use in England culminated in a [briefing note](#) that gained widespread media and policy attention (see [Section 2](#)).

The media interest in electric vehicles and petrol/diesel phase out has, and will continue to, lead to wider dissemination activities for this team, directed at both the general public and national policy. For example: the consultation response and ongoing engagement with the UK Government's Electric Vehicles and Energy Taskforce, and a new parallel task force – Road Automotive Power Infrastructure Review (BEIS/OLEV).



Further engagement within the theme has included extensive technical presentations, media interviews on radio and TV, consultation responses, and expert advice to panels.

Two projects funded under the CREDS ECR (see [Section 5](#)) call are beginning within Theme 2.

- **Facilitating policy change for low carbon mobility: the role of multilevel governance**

This project uses interpretive network and problem analysis to identify the role multi-level governance plays in influencing local-level policy responses to low carbon mobility. It will compare the multi-level governance of two city regions, Birmingham and Cambridge, using original data from policy documents, participatory mapping workshops and semi-structured interviews. The project will provide recommendations for ways to support current UK governance arrangements to enable more effective local policy responses towards low carbon mobility.

- **Decarbonisation of coastal shipping in UK**

This project will identify the most suitable geographic locations to establish green and blue hydrogen and ammonia as zero-carbon marine fuels to facilitate the best possible early adoption and subsequent scale-up. The project is developing a set of key indicators and criteria that can be used to ascertain the suitability and success of a marine transition to alternative fuels that reduce emissions and develop long-term sustainable energy demand.

3.3 Materials and products

All projects in the theme are now well underway, and are making good progress.

A report (written in collaboration with Aether) published in May 2020 – [A data strategy to promote the clean growth of UK industries](#) – found that data are not currently good enough to provide robust evidence, and that there is an urgent need for a public, high-quality data strategy which gathers linked data. The report concluded that ideal dataset(s) should be readily updatable, open access, and independently managed. The report has been promoted with a policy brief, news story, social media activity and an online meeting with BEIS.

Industrial energy demand projections have been modelled for the steel and cement industry, resulting in reports, an academic paper and presentation at [ECEEE Industrial Efficiency online](#) in September.

A modelling approach grounded in stock dynamics has been used to assess the interplay between a number of energy and resource demand-reduction options, including: production efficiency; product lightweighting; reuse and recycling; material substitution; lifetime extension; product switching; and changes to the service supplied.



Initial findings and a modelling framework that can be applied to multiple products and materials focusing on passenger cars was presented at a conference.

A literature review on consumption-based mitigation options across various end-use sectors looked at household-level consumption data to illustrate the distribution of carbon footprints and consumption within 26 European Union countries, regions and social groups. This has resulted in many articles, blog posts and journal papers, for example, [Quantifying the potential for climate change mitigation of consumption options](#). It was launched in May with an [article on the BBC website](#) that reached half a million hits within the first week of being published. Most households have too large a carbon footprint: this needs to be dealt with at a systemic (not individual) level by policymakers, for example, by not incentivising luxuries such as air travel, and better addressing car dependency that is most acute for people with lower incomes. A simplified figure from the Environment Research Letters paper has been submitted to the Summary for Policy Makers for the next IPCC report.

Work on exploring how the use of materials and products throughout the supply chain can deliver a reduction in industrial energy use has included an independent report on industrial decarbonisation policies to inform the Committee on Climate Change's (CCC) recommendations on the UK's 6th Carbon Budget. This involved extensive engagement with CCC analysts, BEIS, Energy Systems Catapult, industry and the third sector (for example, Green Alliance). Three stakeholder workshops have taken place and a stakeholder survey was launched and completed. The findings will be published in December 2020 to coincide with the publication of the CCC's recommendations.

The project on reducing energy in construction, including a new UK standard for whole life carbon assessment in buildings and a UK roadmap, will be substantially affected by COVID-19. So far, we have engaged with eight different sets of construction project partners (clients, architects, contractors etc.) as part of the Embodied Carbon Living Lab where we provide technical advice on embodied/whole life carbon and in exchange partners provide data and trial opportunities. These interactions will continue remotely, but since many construction companies are severely affected by COVID-19 we are unlikely to be able to engage with new partners. As a result, we will undertake alternate work on the same topic. This has already begun, for example, with a recently completed report for Zero Waste Scotland on embodied carbon, prepared in conjunction with Scottish partners.

We have collaborated with other research programmes (Cardiff (CAST) and Manchester, Oxford), NGOs (Oxfam, Climate Outreach) and internationally to contribute to the UNEP Emissions Gap report on lifestyle change, How can equitable low-carbon lifestyles be achieved? Behaviour change, collective responses, and routes towards rapid policy shifts.

3.4 Flexibility

The Theme is progressing well, with five live projects out of the six initially planned, including: flexibility: past, present and future, measuring flexibility of demand, conceptualising flexibility, flexible demand-side technologies and temporality; and price and time elasticity.

In the period of this annual review the flexibility theme generated a book – [Appraising the Economics of Smart Meters](#) – and five journal articles (covering time of use tariffs, conceptualising how time is represented, barriers to demand-side response, time-use methodologies applied to residential electricity demand, and links between hot weather and electricity demand in Italy). Researchers successfully recruited historians and other academics for a special issue in Energy History on Flexibility in the Past, and ran a 2-day workshop for contributors to discuss the draft papers. These papers are now submitted to the journal.

Our international visitor, Max Kleinebrahm (Karlsruher Institut für Technologie) visited us between February and March 2020. Our collaboration on flexibility and machine learning produced a conference paper which was submitted to the 34th Conference on Neural Information Processing Systems, Vancouver, Canada, and a journal paper which is about to be submitted. The other two international visitors (Dr Yamaguchi from University of Osaka and Dr Yilmaz from University of Geneva) have started taking part in our online theme gatherings, and will implement their plan of collaborative research remotely.

We have provided regular advice to policymakers, including to: Ofgem on forward-looking charging review and half-hourly settlement reform; Defra on resource efficiency, waste reduction and consumption emissions; and the British Standards Institute on smart electric vehicle charge point standards. The theme has also provided [responses to consultations](#) including the Energy Networks Association consultation on flexibility. Engagement activities also included many presentations at events, and webinars and workshops. Part of Theme 4's ambition is to engage in dialogue with other themes to interrogate how timing of energy demand and flexibility are taken into account in other streams of work within CREDS. A CREDS conference on 'Flexibility, Time and Energy Demand' was planned for April 2021 but this has been postponed until 2022 due to COVID-19. Instead, we initiated a series of online events to attract international excellence in flexibility research and facilitate collaborations. Accordingly, the first of three flexibility reading rooms was held in July on Conceptualising Flexibility. This was well attended, with a mix of engineers, physicists and social sciences, plus the editor of Time and Society. The second reading room is scheduled for 1 October 2020 on the topic of seasonality, with more planned for 2021.

One project funded under the CREDS ECR (see [Section 5](#)) call was allocated to Theme 4:

- **Using electric vehicles as distributed energy storage systems: a digital twin based approach**

This project will investigate how digitisation would optimise the vehicle-to-grid (V2G) process in conjunction with distribution grid constraints, the availability of local renewable energy resources and customers' preferences. This project will develop a durable and reliable V2G-based demand-response system by implementing a digital twin-based energy management scheme which accurately calculates the mobile storage capacity in real-time, and uses it to achieve a balance between the local generation and local demand.

3.5 Digital society

Work within the Digital Society theme is progressing well, and we have published a total of 21 academic papers with several more in submission. Our project *Reviewing the evidence on ICTs and energy consumption*, involved three systematic reviews: *E-materialisation*, *E-working* and *E-sharing*. Each one reviewed the evidence for impacts of these trends on economy-wide energy consumption. Two papers, on *E-materialisation* (the use of ICT to replace physical goods such as newspapers, books and shopping) and on *E-working* (teleworking), have been published in *Environmental Research Letters*, as part of a special edition on the use of systematic reviews for climate and energy policy. The teleworking paper attracted significant media attention with articles in the *Telegraph*, *iNews* and *Forbes*, and generated interest from BEIS and the IPCC (see [Section 2](#), *Ending the daily work commute*).

The review of the energy impacts of *E-sharing* (IT platform-enabled sharing of physical goods such as cars and appliances) is in progress. We have completed interviews and surveys with the *Library of Things (LoT)* team (about how the system and borrowing platform works) and are currently analysing the responses.

The project on anticipating future impacts of ICT on energy consumption has collected data on the price and consumption of communication for the UK, and completed analysis in income and price elasticities of communication. Data collection for postal and telephone prices in other countries is underway. The recruitment process for a new researcher was delayed by the pandemic, but the post has now been filled and further work has begun on developing and analysing scenarios for the impacts of digitalisation on energy demand and economic output.

Research into the use of ICT for new energy service business models is now complete, and one paper has been submitted with a second paper being written in collaboration with Theme 6 Policy. Findings from the project were also turned into an innovation brief supported by the core team, and were fed into the [Greater Brighton Energy Plan](#) and have also resulted in further impact accelerator funding from Sussex University.

The funding will establish a new [Innovation Forum](#) that will create space for collaboration, exchange and innovation to drive decarbonisation for the Greater Brighton region.

The work on accelerated diffusion of smart meters involved comparative case studies of smart meter roll-outs in three countries: Norway (a clear leader, state-led rollout), Portugal (moderate leader, a DSO-led rollout) and the UK (supplier-led rollout). A paper summarising the results has been submitted and the second phase of the project is currently underway.

The project on expectations for automated vehicles has completed the 'professional' Delphi survey and 3 rounds of 'public' Delphi surveys, and focuses on the 'three revolutions' (electrification, sharing and automation) as ways to reduce transport energy demand.

We have produced a range of papers for the user acceptance of smart homes project looking at gender, vulnerability, domestic violence and family power demographics related to smart home technologies. It has also benefited from a fruitful collaboration with Energy Systems Catapult's Living Lab.

As part of the work within anticipating future impacts of ICTs on energy consumption we hope to explore in more detail how ICT behaviour may change as a result of the pandemic.

We contributed to two government consultation responses/calls for evidence.

One project funded under the CREDS ECR (see [Section 5](#)) call was allocated to Theme 5:

● **Social entrepreneurship at the grid edge**

This project is investigating how community groups are responding to opportunities for community-led, renewable electricity generation that are appearing 'at the grid edge'. Demand-side response and collective self-consumption can match local demand-to-supply, opening up opportunities for more distributed renewable electricity generation. We are drawing on place-based entrepreneurship theory and critical infrastructure studies, and comparing two countries (the Netherlands and the UK). This project will then work with diverse community groups in Newham to co-design collective self-consumption projects that contribute to Newham's climate strategy and generate local value, such as social cohesion, poverty reduction, wellbeing and GHG emissions reductions.

3.6 Policy and governance

The theme is progressing well, with all projects underway and a steady stream of outputs being produced. These include conference papers, book chapters, journal articles (including in high status journals such as Nature Energy), as well as several blog articles on the CREDS website, and consultation responses. Three of our team are co-editing a forthcoming Research Handbook on Energy & Society, part of a series by Edward Elgar Publishing. The book brings together contributions from all areas of this theme including chapters on Comparing local energy efficiency and heat policy in England and Scotland, The social impacts of peer-to-peer (P2P) energy trading, and Energy policy for buildings fit for the future, as well as contributions from other themes, such as transport.

Despite the challenges of the coronavirus pandemic, the policy theme has active, ongoing engagement with a range of stakeholders, particularly in industry and government. We contribute to technical and policy working groups, including engaging with renovation quality standards development (residential retrofit PAS 2035/2030:2019, and non-domestic buildings, PAS 2038). A Scottish session at CREDS WCM6 that brought together Scottish Government with CREDS researchers from Edinburgh led to an invitation to present a Seminar for Scottish Government Heat and Energy Efficiency Team (August). One team member sits as a Commissioner on Scotland's Infrastructure Commission which is now in phase 2 and focuses on governance structures to advance investment in infrastructure for a Net Zero Carbon inclusive economy. Other engagement with policymakers, includes contributions to several calls for evidence such as [BEIS' consultation on energy-related products](#).

In response to COVID-19, we are involved in new initiatives and finding new ways to engage audiences with our research. The team is undertaking new work around training for the construction industry, which includes contributions to the Construction Leadership Council Industry Recovery Plan, and is feeding ideas into HM Treasury for economic recovery, including housing retrofit. The peer-to-peer trading game (Watts the Deal?), has been progressed with an online version, as delivering it in person is no longer possible. The response to the game has been very positive, with tens of decision-makers from communities, regulatory bodies, local authorities and NGOs benefiting from experiential learning and discussions about P2P trading.

Work continues on our research themes, with timing and research methods adjusted as necessary. Investigations into building renovation continue, with increased focus on the non-domestic sector. Research on multi-level governance has included a comparative review of English and Scottish policy frameworks for energy efficiency in buildings, and routes to decarbonising heating. Work on City Deals and energy demand continues. The research on consumer demand for P2P energy trading planned to run surveys in UK and Switzerland, but these were delayed and will be run in the next period. The project on policy asymmetry (prioritisation of supply issues over demand) has started by collecting data from cooperative energy, community energy and social enterprise representatives, and energy demand experts using an online survey (Menti) and in-depth interviews.

This theme is hosting three international visitors from Pakistan, Israel and The Netherlands. One visitor arrived in February and the other visits are on hold due to COVID-19, but work is continuing remotely where possible. For example, we are editing a journal special issue on personal carbon trading with our Israeli visitor.

Two projects funded under the CREDS ECR call are linked into Theme 6:

- **Old for new? Mapping skills and communication networks for local traditional and off-site modular building energy retrofit**

This research will map the skills and communication networks of supply chain actors in local traditional on-site retrofit of homes and compare it to newer, off-site, modular ways of working. Most people retrofit their homes incrementally using local tradespeople, but this traditional, on-site strategy is unlikely to meet climate targets. An alternative way of working is to manufacture a new building with more efficient insulation and appliances in one unit, off-site. This project will examine who is involved, what skills they will need and whether it will deliver energy retrofit at the speed and scale needed to meet climate targets.

- **Adding another layer? A future for clothing in heat demand reduction and decarbonisation**

This project aims to inspire greater research and policy interest in clothing and a greater recognition of its potential significance in the transition to low-carbon heating. Reducing demand for heating in homes, and elsewhere, clothing could make an important contribution but tends to be overlooked. We will investigate what we currently know about how different styles of clothing affect the demand for space heating, imagine future scenarios to help clarify knowledge gaps and assess the role the fashion and clothing industry could play in this area.

3.7 Decarbonisation of Heat

The Decarbonisation of Heat Challenge focuses on the system architecture of decarbonised heat rather than specific technologies. To do this, we are reviewing the literature for how heat can be decarbonised; analysing and further developing existing whole energy system models (UK TIMES model (UKTM) and ESTIMO), and evaluating potential social, regulatory and governance implications of findings. An initial review of the way in which energy system modelling has supported energy and decarbonisation policy over the last 15 years is complete and has resulted in an article in [Energies Heat Decarbonisation Modelling Approaches in the UK: An Energy System Architecture Perspective](#). The findings have fed into the second part of the work on developing the energy system models with respect to treatment of energy system architecture.

We have made significant progress with UKTM. UKTM is a least-cost optimisation model based on life-cycle costs (2010–2050) of competing technology pathways. It is the successor to UK MARKAL, and has been used by UK government since 2015.

We have run it in myopic mode to better represent some aspects of real-world policy-making (using a 5-year period, with a foresight of 10 years instead of perfect foresight of 40 years). This allows investigation of the evolvability of the system in terms of costs and technology options. A Monte Carlo Analysis (MCA) provides probability distributions of possible outcomes to look at the uncertainties of certain parameters.

The ESTIMO model simulates the UK and European energy system on an hourly basis, as driven by social activities and meteorology. It is used to design, simulate and cost national systems with different heat shares. Three different heat shares have been explored – consumer heat pumps, district heating heat pumps and electrolytic hydrogen boilers. ESTIMO uniquely allows the exploration of weather impacts on whole energy systems over long time scales, so that flexible architectures that are resilient to extreme weather events and climate change can be designed in. Further development is ongoing. Results from the model have contributed to the Royal Society report on long-term storage needs.

Information about the work was shared with stakeholders in a joint heat/core team workshop, with a view to supporting strategic decision-making in Government and industry. Participants reviewed the results from our two modelling teams and from stakeholder interviews, and then took part in breakout group discussions. Other engagement during this period has included representation at the All-Party Parliamentary Group for Energy Studies (PGES) on the impact of net zero and energy infrastructure in March 2020, a response to the [BEIS consultation on Heat Decarbonisation](#) and a keynote presentation to the Energy Policy Session, [Lost Generation: System Resilience and Flexibility](#) MIT AB 2020 Online Conference.

The development of a Special Issue of Energies on “Decarbonising Heating and Cooling” (Lowe & Chiu eds.) is under way.

A proposal was submitted, under the UKRI Decarbonisation of Heating and Cooling 2020 Call, for 3 years’ funding. This bid builds on the System Architecture foundations laid in CREDS Decarbonisation of heat Theme.

There were two themes that started during this period – Theme 8 on Fuel and transport poverty in the UK’s energy transition (FAIR) and Theme 9 on Decarbonisation of the steel industry.

3.8 Fuel and Transport Poverty – FAIR

The FAIR theme is investigating who may be vulnerable to both fuel and transport poverty in the UK’s transition to net zero. This means examining the likelihood that a household will experience fuel and transport poverty, how it impacts on their well-being and how they can respond to it. We will also look at where these effects are seen so that we can understand both the systemic and spatial drivers in the UK. Further work will look at how those who are already vulnerable may be affected by an energy transition, and whether new inequalities may emerge. As a result we hope to propose solutions for an energy transition that promotes a more just society.

The project has been progressing as best as it can during the COVID-19 pandemic as it was due to start extensive data collection via face-to-face interviews in April 2020, but these have been delayed. In the meantime, good progress has been made with a systematic literature review to develop a conceptual framework. We are conducting a comparison of literature on fuel poverty/energy poverty and transport poverty, specifically examining the socio-demographic groups that are vulnerable to each problem. This has led to the publication of a policy briefing supported by the core team ([Vulnerability to fuel and transport poverty](#)) that was developed as a follow-up from a meeting with HM Treasury. The review also fed into the recruitment strategy for household interviews, and informed a forthcoming publication under review in Joule.

The team is finalising details of the recruitment processes for household interviews with theme partner Energy Saving Trust (EST). Ethical approval from the University of Sussex and the University of Edinburgh is secured, and EST has developed a step-by-step recruitment plan. A CREDS Data Management Plan is in place. However, there have been challenges to the start of data. There are two main issues – a delay in response from EST's partner organisations, which were busy helping vulnerable people with the initial pandemic response back in March/April 2020, and a delay in signing a data-sharing agreement between EST, Sussex and Oxford. While this agreement between project partners is being finalised, an additional online platform is being used as further route to recruit study participants (and which does not require data-sharing agreements). As a result, we were able to start the household interviews by online/phone in October 2020.

We have developed engagement plans, a stakeholder map and a communications plan together with the core team and partners Green Alliance and EST, and have made changes accordingly due to COVID-19. As part of cross-theme engagement within CREDS, there are regular meetings with the Transport theme (Excess project team) about data, sharing tips on data collection, and collaboration on future publications. FAIR has also engaged externally by hosting a first stakeholder engagement event (September), bringing together policy representatives from the UK government and the devolved administrations. This event introduced them to the project and its themes, laying the groundwork for future interaction. Anecdotal feedback showed that they were interested in our approach. Green Alliance has also started conversations with civil servants and some MPs, and has started to publish blog articles on its [Inside Track site](#). FAIR was also a panel member at the National Energy (NEA) Action Warm Homes Week panel following a ministerial address on a session entitled [Fuel Poverty and Climate Change: How can we hardwire fairness and equity into the next zero journey?](#) There was also social media activity on twitter during the panel with [#warmhomesweek](#).

3.9 Decarbonisation of the steel industry

The work in this theme is focused on integrated strategies to eliminate the dependence of iron and steel production on fossil carbon. The steel industry is one of the most carbon intensive sectors and is very challenging to decarbonise. There have been efforts to develop various routes for decarbonising steel production, such as use of hydrogen, carbon capture and storage (CCS), biomass and some industry roadmap development. What is lacking, and our work aims to provide, is truly integrated strategy that incorporates technologies, policies, stakeholders and especially their interaction.

The work involves two main areas: expert interviews (now to be held online) with those in the steel industry to develop stakeholder visions; and modelling using the MATLAB-based energy system tool to investigate the optimal combination of energy system technologies to decarbonise the steel industry.

In the first area, we are developing the theoretical framework that will be used to create guidelines for the interviews and to analyse the data once interviews are finished. The interviews will capture five main issues relevant to the steel decarbonisation process: 1) expectations, interests, and strategies, 2) policy, 3) potential impacts of decarbonising the steel industry in the organisation's interest, 4) technological development; and 5) perceived obstacles to steel decarbonisation. The interviews will be scoping semi-structured interviews. The application for research ethics approval from the University of Leeds Faculty of Environment Research Ethics Committee has now been approved. There have been initial discussions with several stakeholders including British Constructional Steelwork Association (BCSA), Royce Institute, Swerim, University of Sheffield, UK Steel, and [BHC Ltd](#). Further engagement activities and awareness raising has taken place including attendance at the BCSA Sustainability Group.

In the second, the energy system model has been further developed to fully account for the various components required to meet the electricity and hydrogen requirements of fossil-free primary steelmaking based on hydrogen direct reduction and electric arc furnaces. Dispatchable backup generation (in the form of CCGT + CCS and biomass + CCS) is now included in the model, along with energy generation and storage costs, and projected fuel and carbon costs recently published by the Department of Business, Energy, and Industrial Strategy (BEIS). The results are being written up for a journal paper.

4. Approach to Equality, Diversity and Inclusion

CREDS has adopted a [policy and action plan on Equality, Diversity and Inclusion \(EDI\)](#) that was published in April 2019. Our aim is to foster an inclusive culture within the Centre, which promotes equality, values diversity and maintains a working and social environment in which the rights and dignity of all our staff, students, partners and stakeholders are respected. This fulfills our legal obligations under the Public Sector Equality Duty, but goes further than the legal requirements.

We keep EDI visible in the consortium with sessions at every WCM (covering unconscious bias, career progression, feedback from the EDI working group, staff survey), items in the internal newsletter (the Consortium Update) and external newsletters, items on the website, and EDI working group meetings.

A year after publishing our EDI plan we reviewed the progress in implementing it and published the [EDI Annual report](#) and briefing paper in June 2020. The main challenge to CREDS is that many aspects of EDI are determined at the institutional level, which means the Centre's influence is limited, although we are sharing what we have learned with the institutions that are part of the consortium.

Some of the actions within the plan have had to be delayed (such as work to promote better career progression for researchers) due to resource constraints, since all the EDI working group are voluntary, including those within the Core team. To address this, we have decided to use the Flexible Fund to resource an EDI post (one day per week, 0.2 FTE). It has been agreed by the Executive Committee and Advisory Board and is currently going through the recruitment process at Oxford. We will continue to monitor the implementation of the EDI plan and revise the actions as required. A summary of the report is provided below.

4.1 Recruitment

The Plan included four actions relating to the diversity of recruitment and appointment panels, explicit statements about diversity in job advertisements, and monitoring and reporting on these areas.

Following a survey of the 15 institutions that were part of CREDS in 2019, the main results were: three institutions had a statement in job descriptions and adverts encouraging applications from specific under-represented groups (e.g. women and minority ethnic groups); six institutions out of 15 had staff involved in recruitment and selection undertake equality and diversity training, including training in unconscious bias. Half of the 45 posts were recruited competitively (job adverts, interviews) and half non-competitively (staff being redeployed from a previous role). We collected gender statistics for both types of post. For researcher positions, the M to F split of applications was 74 per cent to 26 per cent, and of appointments was 80 per cent to 20 per cent. The higher proportion of males recruited is consistent with the higher proportion applying for these posts. For non-researcher positions (i.e., administrative support and knowledge exchange roles), the number of recruitments was smaller. The M to F split of applications was 37 per cent to 63 per cent and of appointments was 0 to 100 per cent. The M to F split of appointments for staff redeployed onto CREDS was 61 per cent to 39 per cent. These are predominantly researcher posts.

4.2 Bullying and harassment

The plan aims to ensure that all CREDS staff are made aware of the bullying and harassment procedures of their employing institution during induction since policies and their enforcement are the responsibility of each institution. As four CREDS staff (out of 50 who completed the survey) had experienced bullying or harassment 'rarely' or 'occasionally' since being at CREDS, we are planning an awareness-raising campaign about this issue. We also plan to provide information on the CREDS procedure and key contacts. The survey of institutions that had recruited staff indicate that three institutions made staff aware of the bullying and harassment procedures of their employing institution, and included information on flexible working during induction. Clearly, this could be improved and we will write to institutions at least once a year to provide them with this information.

4.3 Flexible working

The plan contains two actions on flexible working: access to meetings remotely and information on flexible working availability at induction (see above). Both physical Whole Centre Meetings since publishing the plan have enabled people to access meetings online, although uptake has been low: two staff requested live joining access to WCM5 and none for WCM 6. The meetings were also recorded and made available on Microsoft Teams after the meeting. Feedback from one online participant was that accessing recordings is more useful than joining online live, since one reason people do not come to WCMs is because they have other commitments at the same time.

Clearly since COVID-19, remote working is now the norm. WCM7 (June 2020) was our first entirely online whole centre meeting with around 80 people attending, and the agenda was significantly adjusted to suit the change from a physical to an online format. An event report is available on request. The next WCM8 in March 2021 is also planned to be completely online. We will use the lessons learned during this period to improve the online experience for those attending meetings remotely in the future.

4.4 Career progression

There are three actions relating to career progression with a commitment to run a dedicated call and mentoring scheme for researchers to lead projects ([Section 5.1](#)), and to investigate issues around career progression and job security for staff on fixed-term contracts.

4.5 Communications

The plan promises to ensure that equality and diversity issues are considered in the internal and external communications of the Centre, including the diversity of speakers at events, publication authors, website contributors and images. Monitoring of these aims shows that – blog post authors have a good gender split: 40 per cent of blog articles were written by men, 40 per cent by women and 13 per cent joint (total number of blog articles: 30). Publication authors are split as follows: 72% male, 28% female. Although not all the authors are affiliated with CREDS, this split broadly reflects the male/female ratio within CREDS.

Since the EDI policy was established, we have agreed that images on the website should not generally contain people. In ensuring diversity of speakers at events, one concern has been raised multiple times that those from under-represented groups can be over-burdened with public-facing activities, especially if they are senior. This then leads to the question of whether more junior staff should be asked to take on these roles, especially as in general, junior researchers are more diverse than their seniors.

4.6 Other CREDS initiatives relevant to EDI

CREDS also facilitates the Energy Demand Research Network (EDRN), for energy demand researchers beyond its consortium (see [Section 2](#)), and EDI has been central to the planning of these events. For example, we try to ensure diversity and a gender balance amongst speakers, and promote ECRs where possible. In addition, venue selection criteria have been developed to check the environmental and social performance of venues, including their commitment to EDI (covering such things as the art on the walls, whether they are active in their local communities and how they promote EDI within their own organisations). This improves the EDI impact of the money CREDS spends on events.

The gender pay gap is not part of the CREDS EDI action plan, as CREDS does not determine salaries. However, the institutional questionnaire asked CREDS leads whether their institutions had taken steps to raise awareness of the gender pay gap and support action to address these. Four respondents were unaware of any such steps.

5. Flexible Fund allocation

The use of the Flexible Fund has been extensive this year.

5.1 Early Career Researcher (ECR) Flexible Fund call

The EDI plan committed to reserving at least 30 per cent of the Flexible Fund (this was increased from £750,000 to £1m) to allow researchers to lead projects to enable them to gain proposal writing and project management skills, and PI experience. The call defined those eligible to apply as 'people active in energy research in the UK who have not previously led a project with funding exceeding £100k, and this criteria was thought to be appropriate [according to the evaluation](#). We put additional support mechanisms in place during the call to support capacity building for researchers, such as providing a long window for proposal writing (call published 25/7/2019 – call closed 17/12/2019), offering a webinar to explain the call scope and conditions on 26/9/2019 (49 people attended) and offering a group mentoring scheme (66 people were offered mentoring provided by seven members of the CREDS Executive). Finally, feedback was offered to all applicants: individual written feedback to the 19 shortlisted candidates and individual mentoring sessions (phone calls) to 50 unsuccessful candidates.

We announced the [results of the Early Career Researcher \(ECR\) Flexible Fund Call](#) in June 2020 following a decision-making panel in March. Contracts have now been agreed with all the institutions involved and most of the eight projects will start within the next six months. The projects will be integrated into our existing thematic areas of work and therefore come under the same governance processes as the rest of the consortium. The eight projects are:

1. Using electric vehicles as distributed energy storage systems: a digital twin-based approach. Senthoran Balasubramaniam | University of Coventry
2. Adding another layer? A future for clothing in heat demand reduction and decarbonisation. Janine Morley | University of Lancaster
3. CoCo hybrid project. George Bennett | University College London

4. Decarbonisation of coastal shipping. Nishatabbas Rehmatulla | University College London
5. Social entrepreneurship at the grid edge. Charlotte Johnson | University College London
6. Old for new? Mapping skills and communication networks for traditional and off-site building energy retrofit. Faye Wade | University of Edinburgh
7. DeViz (Defect visualisation via thermography). Julie Goodhew | University of Plymouth
8. Facilitating policy change for low carbon mobility: the role of multilevel governance. Louise Reardon | University of Birmingham

We also carried out a thorough evaluation of the ECR Flexible Fund call, the effectiveness of the process and various aspects of equality, diversity and inclusion (EDI) that was based on a survey of 110 people. The [evaluation report](#) is available on the website. The report has been shared with the consortium, UKRI and UKRI's Energy System projects.

We have developed a future plan for a researcher-led programme of cross-institutional events, drawing on the views of ECRs in the Centre during a two-day event on 22–23 October 2019. The event included training on How to write a good funding proposal. They were also given information about other funding opportunities available to ECRs and [listened to a talk from an ECR](#) who had just successfully applied for a £1 million grant. These resources were put on the website and mentioned in the CREDS Consortium Update (our internal consortium newsletter) and CREDS Newsletter (our external newsletter for the wider Energy Demand Research Network and other interested stakeholders) so that they were disseminated to a wider audience. We have also added a [designated ECR area](#) to the CREDS website that includes guidance material [How to prepare a Pathways to Impact Statement](#) and a [description of the funding landscape](#).

5.2 Flexible Fund Impact Acceleration Awards

CREDS launched its Flexible Fund Impact Acceleration Awards (IAA) in November and has funded three proposals. One will support work with local government to develop seven decarbonising transport briefs, another to develop a carbon calculator for transport for local authorities, and the largest is to expand our policy engagement work beyond the existing activities by Kay Jenkinson, Knowledge Exchange Manager for Policy to more central government departments. The Government Affairs Manager (Peter Mallaburn) is responsible for expanding and managing our relationship with central government and, with the Core Team as a whole, to enhance our impact on policy, principally working with the buildings, heat and governance theme leaders to reach BEIS, MHCLG and the Treasury.

5.3 Core Team resourcing

We have allocated additional funding for the core team from the Flexible Fund to recruit a Knowledge Exchange Manager for Business as we recognised that the business audience did not have sufficient attention within CREDS. Unfortunately, Aimee Eeles started the role at the beginning of March, just as COVID-19 emerged, so her work has been delayed. She is developing a stakeholder map, has liaised with our main business-related themes – materials and products, and steel decarbonisation, and is developing a strategy for engagement with the business community.

5.4 Integration Projects

The Flexible Fund has also funded our four ongoing integration projects. One of the criteria within the call process for integration projects is that they need to work across more than one theme – three of these are COVID-19 related projects:

- 1. The effect of COVID-19 on energy use in homes** led by Tadj Orecsczyn. This involves a survey of 1700 people who are already participating in the Smart Energy Research Lab (SERL) and staff from Core and Themes 1 and 6. This means that we can join together the responses from the survey with their smart meter data to assess their energy use before, during and after COVID-19. The survey was carried out on paper and online and has resulted in 1000 responses. We are currently analysing the data.
- 2. The effect of COVID-19 on travel and socialising adaptability** led by Jillian Anable. This study (co-funded by many partners including CREDS Theme 2, Transport Scotland, ClimateXChange and Liverpool City Council) aims to do a three-wave survey (before, during and after) looking at how travel and socialising behaviour and patterns have changed as a result of the pandemic. There has been an extensive quantitative survey of 9,600 participants in 10 city regions¹ in England and Scotland via YouGOV. This has been followed up with 110 interviews in five locations and interviews with policymakers and academics. Further survey and interview work is ongoing. So far, there has been an initial analysis of the survey and interview data and the [results are published along](#) with a number of blog articles. One paper has been submitted.
- 3. The contribution of energy demand in the economic recovery package post-COVID-19** led by Clare Downing. This study is user-needs led – we have asked policy decision-makers what information they are looking for to support their deliberations, and involves staff from five Themes. We will then apply our collective existing knowledge and new evidence to address their knowledge needs and make suggestions for policy solutions to move the UK in the direction of an equitable transition to net zero. So far, we have had discussions with BEIS, DFT, MHCLG, Transport Scotland, the Scottish Government and LGA, and have had various requests for further support.

¹ Aberdeen, Aberdeenshire, Edinburgh, Glasgow, Ayrshire, Bristol, Lancashire, Liverpool, London, Manchester, Newcastle.

4. Low Energy Demand Scenarios led by John Barrett. The project is developing quantified low energy scenarios for the UK and involves staff from six Themes. The project is analysing how energy demand can be reduced through a combination of shifting, improving and avoiding demand. It will quantify final energy demand up to 2050 for all the major energy service demands – mobility (transport), shelter (residential and non-domestic buildings), materials (industry), food and products (appliances)) using the Shift, Improve, Avoid framework. It is constructing a 1.5 degrees C compliant and equitable carbon budget for the UK, using low energy service demands as inputs into the UK TIMES model to define a downscaled energy system and considering a policy framework to realise these reductions. The majority of the modelling and narrative for each sector is complete.



About CREDS

The Centre for Research into Energy Demand Solutions (CREDS) was established as part of the UK Research and Innovation's Energy Programme in April 2018, with funding of £19.5M over 5 years. Its mission is to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable, low carbon energy system. CREDS has a team of over 140 people based at 24 UK universities and organisations.

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