DEMAND
DYNAMICS OF ENERGY, MOBILITY AND DEMAND

The DEMAND Centre's research

The Centre's research programme is driven by a distinctive theoretical approach, based on three key propositions. First, that energy is used not for its own sake but as part of accomplishing social practices.[1] Energy demand is consequently dynamic, social, cultural, political and historical: it is bound up with the temporal rhythm of society and with what people do. Second, energy demand is profoundly shaped by material infrastructures and institutional arrangements. In a very literal sense demand and the means to consume constitute each other.[2] These means of consumption encompass systems of provision and supply – from grids, power stations, road and rail networks through to the multitude of devices with which end-users engage (computers, heating systems, cars etc.).[3] Third, these systems reproduce interpretations of normal and acceptable ways of life. Concepts of need and entitlement to energy and mobility are consequently embedded in popular and policy discourse, in standards of many forms, in estimates of future energy demand and in related programmes of planning and investment.

These ideas suggest that energy demand is about more than the public acceptance of new technology, and more than the supply-oriented steering of transition pathways[4] as described by sociotechnical models of innovation.[5] If we are to understand the fundamental dynamics of demand and engage with related issues of justice, need and entitlement we have to develop a more thoroughly integrated account of the relation between technological provision and social practice, and of the spatial and temporal ordering of end uses. For example, knowing how end use practices vary, when and where they occur, and how and why they change over time is crucial if carbon reduction policies involving real time management or the decentralisation of supply are to have any chance of success. In taking this approach we move into new territory, redefining the problem of energy demand and the range of possible solutions. As such, the DEMAND Centre's programme represents a step change in how end use and energy demand are conceptualised and tackled.

By concentrating on end use practices rather than on pre-defined sectors or resources our research is designed to generate knowledge and inform strategies capable of having lasting impact on the UK's energy demand, and on how this demand is managed in different settings.

Research challenges

Our research programme revolves around a number of specific challenges addressed through four complementary research Themes and a fifth explicitly focused on integration and application. These challenges are to:

1. *Develop new ways of analysing the relation between the dynamics of end use practices and dynamics of energy demand, moving beyond reliance on aggregate patterns and averages.* Projects in Theme 1 make creative use of existing quantitative data sets to identify variations and trends in the social practices that shape energy demand, feeding analysis into the rest of the research programme and into estimates and models of future consumption.

2. *Provide insightful and useful accounts of how and why end use practices vary over space, time and social context, and of the processes through which they evolve and impact on energy demand and greenhouse gas emissions.* Theme 2 goes into detail, analysing end use practices that are currently changing in ways that matter for energy demand – specific projects focus on

the use of domestic IT, increasing mobility amongst older people, business travel, and the relation between home, work and leisure.

3. *Increase understanding and knowledge of the spatial and temporal flexibility of end use practices and of how end use practices and related infrastructures might be adapted and managed to reduce demand.* Theme 3 analyses the development and constant adaptation of end use practices and of the hard and soft infrastructures (gas, electricity, transport, logistics systems, organisational procedures) on which they depend, identifying the potential for future transformation across different sites and time scales – including smart grids; building design and management; control systems; district heating and infrastructures for electric vehicles.

4. *Address fundamental questions of need and entitlement, generating new thinking and informing public policy and debate about how much energy consumption and mobility is required to participate effectively in society and how this might change.* Projects in Theme 4 deal with topics of energy and justice; with transport stress and the costs of mobility, and with implicit forms of energy demand governance.

Theme 5 synthesises and evaluates the practical and conceptual significance of Themes 1-4 with reference to three cross-cutting questions (a) How is energy demand constituted and made? (b) How and why do forms of end use energy demand change? (c) Where do societally viable opportunities for steering and radically reducing demand lie?

Research Programme

Theme 1: Trends and patterns in energy demand

Analyses of historical trends and future projections of consumer energy demand are typically broad-brush, based on current levels of consumption modified by forecast population and GDP changes.[6] The detail of when, how and by whom energy is used is hidden from analytic view, but is crucial for estimating future demand and assessing responses to smart grid/decentralised systems: for example, which end uses are likely to change, how do practices vary, how does this affect peak load? There is a clear need for substantially more sophisticated analyses of spatial, temporal and social variations in end use practices in order to produce more refined scenarios of future demand, and to inform current policy initiatives and critically examine their effects. Theme 1 consists of three linked projects that creatively integrate and analyse existing data to meet this need and inform other projects in the DEMAND Centre's programme.

1.1 The structure and social distribution of end use practices

Rationale: In contrast to current approaches relying on statistical aggregations and averages, this project seeks to provide a detailed analysis of the structure of contemporary energy end use practices (using IT, heating, cooking, laundering, working, travelling etc.) by time of day, day of week, time of year and disaggregated by socio-demographics, location, social context and lifestage. Analysis of *variation* within and across such groups is crucial for understanding the range of energy used for similar practices, and for identifying which practices are more variable in this respect.

Method: This methodologically challenging project requires re-conceptualising activities for which data already exists, and in many cases developing suitable proxy indicators in order to reveal patterns and distributions of end use. Analysis will explore variations in terms of location (urban, rural), seasonality; demographics, including occupancy, also showing where end use practices take

place - at home, work or on the move – also distinguishing between regular and infrequent practices and the mobility they entail. Secondary data sources including the UK 2005 Time Use Survey and the Multinational Time-Use Study dataset and six years of the London Travel Diary Survey will be used, with findings validated against conventional travel surveys (National Transport Surveys) and bespoke energy/activity monitoring datasets made available by Centre partners, by third party collaborators or through 'data fellowships'.

1.2 Time pressures and peak demand

Rationale: Present and future strategies of demand management depend on detailed knowledge of *when* end-use practices occur, how they are sequenced and how flexible they are in terms of timing and duration. This is key for estimating and influencing the risks of peak demand. Research in this project will generate results that are important in their own right, and identify topics that deserve more detailed analysis within Theme 2 and beyond.

Method: Using similar data sources to 1.1, this project uses novel activity sequencing approaches[7] to produce innovative insights into the synchronicity of practices within households, determining which are predictable and which are more variable; identifying the relation between peak demand in mobility (e.g. congestion) and in energy used in buildings; specifying time pressures and hotspots of energy demand, and the temporal and spatial flexibility of routine and infrequent mobility practices. Finally, this work will test the extent to which patterns revealed by the time-use data reflect measured energy consumption.

1.3 Trends over time

Rationale: Future demand depends on the energy intensity of end use practices and how they *change*. Having established methods of representing and analysing the distribution (1.1) and timing (1.2) of end uses the next step is to determine which are changing, at what rate and with what implications for energy demand and CO_2 emissions.

Method: This requires use of historical data sets, tracking changing practices, e.g. occupancy patterns, appliance use, and household routines over time, and using pseudo panels and longitudinal data to show how participation in selected end use practices changes over the life course, and to distinguish between age and cohort effects. Data sources to be used include the 1997-2001 HomeOnline longitudinal timeuse survey, the UK 2005 and 2001 Time Use surveys and historical components of the Multinational Time-Use Study; National Travel Survey, British Household Panel Survey/Understanding Society Survey (since 1991).

Outcome: In combination, the projects in this Theme will (1) improve the representation of demand in current models as used by DECC and the Department for Transport (2) develop new units of analysis and methods for measuring and anticipating changes in relevant end use practices (including timing and location), drawing on social theories of time and time use and (3) inform the assessment of future systems and technologies of provision. This work requires methodological innovation (e.g. to track end use practices over time, to reveal forms of synchronisation), undertaken and shared through a programme of international workshops and publications in collaboration with EDF-R&D and ECLEER's wider international network. Theme 1 researchers will also be involved in quantifying and assessing the energy implications of insights and policy conclusions from Themes 2 and 3, as they arise.

Theme 2: How end use practices change

Building on the results of Theme 1, projects in Theme 2 seek to *explain* processes of change and sources of variation that matter for energy demand. Projects investigate different types of change, concentrating on instances relating the adoption of ICT technologies to new forms of social organisation and demographic patterns, and to the relation between home and work. The common aim is to assess the implications for energy use and the impact of current and new forms of demand management. This work will inform the development of future scenarios of demand.

2.1 Domestic IT use

Rationale: There is no indication that the proliferation of domestic IT/media is slowing (currently around 13% of UK household electricity consumption[8] and 26% of electricity used for lighting/appliances in French homes). To actively manage demand associated with this new 'era' of electrification,[9] we need to know how IT/media has become embedded, and how it has infiltrated, 'individualised' and transformed so many areas of practice. While the power draw of individual devices has decreased the number installed has risen spectacularly: so much so that people often have several devices (smart phone, laptop, TV) running at once. Informed by data on ICT ownership (Theme 1), this project focuses on three demand-critical aspects: (1) What infrastructures do these devices presume? (2) How do IT devices transform other practices, for example, home shopping, planning trips, watching TV, and with what implications for energy demand? (3) How do IT devices, especially portable ones, influence where end use practices take place, and hence where energy is sourced?

Method: 40 households will complete diaries and be interviewed on two occasions. Twenty will be recruited for much closer investigation, using sensors, automatic logging and custom monitoring software to track the time use of specific technologies, computer applications and multimedia and to quantify the energy drawn.[10] The sample will capture variation in terms of household composition (e.g. families, singles, and couples), age and income, and will be defined in collaboration with Project 3.3.

Outcome: Better knowledge of the timing and location of IT related practices and related energy demand, and detailed user analysis important for the development of power and communications infrastructures and individual devices, and for efforts to promote lower-impact technologies and end uses and contain escalating trends in energy demand.

2.2 Business travel

Rationale: We know that business travel accounts for 20% of journeys over 50 km, and for 25% of domestic and international flights,[11] but have little or no idea of what these trips are for, or how needs for co-presence relate to trends in organisational and economic practice such as outsourcing, knowledge production, conferences and training, recruiting, demonstrating and selling.[12]

Method: Data sources including the National Travel Survey, International Passenger Survey, CAA, National Rail Passenger Survey (Passenger Focus), CAA Departing Passenger Surveys, selected company accounts and data from business travel providers will be used to categorise and analyse end use practices and establish which occupations and professions are currently engaging in travel-intensive practices, and how and why this has come to be so. In detail we need to know how working practices vary in terms of the numbers of people who consequently travel and meet, how such patterns change, and where the potential for reducing the need to travel, or for substituting 'real' meetings with other forms of communication lies. Qualitative research (interview based N=80) with a sample of 60 employers, will identify exactly which practices underpin the 'need' to travel (to which destinations, how often, etc.), and help explain how this has come to be the case. The sample design will be informed by the quantitative work and will include public and private sector

organisations that account for disproportionate amounts of business travel (e.g. multi-nationals), or that have adopted new forms of e-mobility (e.g. publishing).
Outcome: Better understanding of working practices and of how and why they vary within and between occupations is needed in order to assess flexibility in terms of time and space (peak demand), the potential for reduction, substitution (with IT, videoconferencing etc.),[13] and/or the likelihood of a substantial increase in business travel.

2.3 Older people and mobile lives

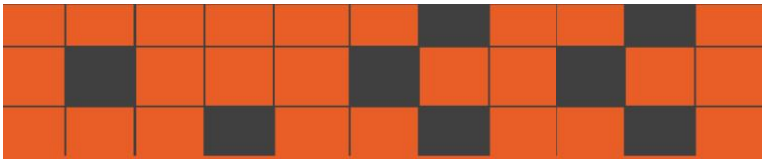
Rationale: Mobility amongst older people constitutes a significant and growing area of demand.[14] The population is ageing and on average health and life expectancy on retirement has increased. Meanwhile, older people are making more long distance trips than ever before and there is evidence that travel is a major aspiration for those who retire.[15] Mobility is often encouraged as a means of ensuring wellbeing and combating social isolation, various policies have facilitated cheap bus journeys and there is a significant market in organised holidays for older people. This project is designed to explain how this 'new' area of demand has been built and how it is changing, and to identify points of potential intervention within the systems of provision involved.
Method: The research will draw on quantitative analysis of patterns of mobility across age groups (Theme 1) to develop a programme of 60x2 interviews with people yet to retire (aged 55-60), those who have retired (between 60-65) and an older cohort (aged between 75-80), selected to represent differences of wealth and social class. Interviews will focus on frequent and infrequent travel patterns, first reviewing past and present arrangements and then exploring future circumstances under which these practices might change. Interviews will be informed by archival work, using secondary sources to track the provision and uptake of services targeted at older people (rail cards, holidays, etc.), and to reveal changes in how older people experience and value mobility. Specialist travel providers, transport operators, policy makers and interest groups will be involved as key informants, and as users of the research.
Outcome: This project will reveal changing trends and practices, showing how and why patterns of post-retirement mobility are evolving, what this means for energy demand, how this might shift under different conditions in the future, and how it might be managed without compromising the social and cultural benefits that follow.

2.4 The dynamics of energy use in daily life

Rationale: In focusing on end use practices we recognise that familiar categories of policy and analysis (e.g. home, work and leisure) do not map on to everyday experience: 'work' can be done at home and on the move, and leisure occurs in many sites and situations. Following Theme 1, this project, led by EDF R&D, examines the changing relation between different end use practices from the point of view of households and their members. One aim is to establish units and categories of analysis that are better attuned to the flow of daily life. A second is to present and compare 'real life' scenarios and combinations of energy-use and mobility, showing how 'portfolios' of high and low energy demanding practices fit together, and how this changes and varies amongst different demographic groups, including single person households. The third is to explain and better understand methods of sequencing and the relative fixity (in time, and space) of the many end use practices of which daily life and energy demand is made.
Method: This project is in two stages. The first involves further analysis of qualitative research undertaken by EDF R&D over the last decade, including 60 face to face interviews conducted in France as part of ENERGYHAB (Energy Consumption, from the Residence to the City: Social, Technical, and Economic Aspects) and the qualitative database, VERBATIM. This will inform new data collection in the UK (50 interviews), mirrored by a parallel study in France (50 interviews), to permit targeted and detailed cross-cultural analysis.

Outcome: This project will inform future quantitative data collection and analysis (linked back to Theme 1); and will provide a more holistic picture of the timing and relative flexibility of energy use and mobility, and of the practice-based constraints involved.

Theme 3: Managing infrastructures of supply and demand



Theme 3 seeks to inform future-oriented debate and decisions about which features of present energy and mobility systems might be abandoned, adapted, augmented and managed to radically reduce carbon emissions over the next forty years. It focuses on the systems and infrastructures on which end use practices depend.

3.1 Adapting infrastructure for a lower carbon society

Rationale: This project identifies openings and possible paths for future adaptation and reconfiguration, both of infrastructures *and* of end use practices. To tackle changes needed in the future we need to know how existing infrastructures – some laid down only recently, others dating from the Victorian era and before - have been adapted, modified and layered one on top of another, at different scales. Our research goes beyond existing work on supply-oriented transitions in urban development[16] and from one fuel[17] or technological regime to another[18] in that our aims, and those of EDF and TfL, are to better understand how the detail of daily life changes and interacts with technologies and institutions of supply, and to determine how traditions, patterns and peaks of demand might be reshaped at a societal scale. This requires conceptual innovation, integrating historical, organisational and social scientific theories of how provision and demand relate, and of how such systems (and related uses) are adapted locally and on a national scale, through increasingly complex organisational forms and markets.[19]

Method: This is an ambitious project which combines historical enquiry with analysis of future options and processes of change. The main empirical research will concentrate on four locales, each site exemplifying a different 'moment' where past demand has changed, resulting in under or over capacity, and where new systems and technologies of provision are being introduced, examples being district heating schemes and "plugged in places" for electric vehicles. In each location we trace the intersection of supply and end use practice. To do so we will analyse local area statistics on mobility and energy use (from Theme 1), and conduct interviews with local and national providers, planners and households (N=52), followed by 4 stakeholder workshops. We will, for example, analyse the introduction and use of London's electric vehicle charging points, examining the challenges involved in augmenting infrastructures and establishing new practices. In addition, extensive archive work will be required to examine and learn from infrastructural change in the past. This will involve following the introduction of gas and electric energy appliances and systems of transport provision and showing how use patterns have changed historically in response to deliberate intervention (e.g. smoke abatement and congestion charging), and crises of supply (post 45, the harsh winter of 1962-3; 1973). Both strands allow us to evaluate the potential for radical change in end use practice, and for substantial, rapid demand reduction. The final step is to test and evaluate insights (e.g. into how end uses and networked technologies 'make' demand and structure opportunities for demand management) with reference to sites of technological-practice innovation, including engineering projects within the EDF-ECLEER network for example, EIFER (Germany), EMERGENT, COLLENER/Smart Grids.

Outcome: Generic lessons about the scope for adaptation and the potential for building lower carbon networks for the future will be fed back and debated with organisations that have a stake in

designing and managing gas, electricity and transport systems. Specific implications will be explored and reviewed in local case study areas. Theoretical frameworks developed in 3.1 will feed into the programme as a whole.

3.2 Negotiating needs and expectations in commercial buildings

Rationale: Commercial, industrial and public sector buildings account for around 20% of UK CO_2 emissions.[20] This project tackles three related questions (1) how, and by whom, are users' needs for heating, ventilation, cooling, lighting and 'small power' defined and negotiated at the different stages of design, occupancy and refurbishment,[21] (2), How do past methods of defining and meeting users' 'needs' structure future opportunities for demand management? And (3) how can rising standards and increasingly resource intensive expectations be curbed at different stages in a building's life?

Method: The first part of the research involves 30 key informant interviews with designers, professional associations, equipment manufacturers/distributors, owners, market-makers (property consultants/developers, estate agents), occupiers, operators and utilities, focusing on how their work is framed by specific interpretations of future users' needs. The second consists of retrospective documentary analysis of three office buildings, one from the 1850s, one from 1970s and one completed in the last five years, in order to reconstruct the history of past refurbishments, identify the design standards and conventions of use in play at the time, and evaluate their consequences for energy demand. Building on the first two parts, the third stage is to work with a number of major developers and landlords (e.g. Land Securities, Hammerson) to explore opportunities for revisiting and potentially challenging current definitions and conventions of user 'need' such that they can be met through a wider range of lower carbon solutions.

Outcome: The purpose of this project is to show how understandings of 'normal' standards are made, how competing interpretations of acceptable, marketable and desirable office environments are resolved and where opportunities lie for managing energy demand by negotiating user needs at different points in the building lifecycle.

3.3 Infrastructures for online shopping: integrating supply and demand

Rationale: Light van traffic has grown by 30% since 2001 and in 2010 accounted for 41 billion miles travelled whilst car traffic levels have grown by only 1% over the same period. This trend, which represents a major challenge for reducing energy use in the transport sector, is in part related to the extensive growth of home delivery linked to teleshopping and online purchasing. This project investigates the making of new systems of supply from the point of view of retailers and related organisations, and of those who shop online. At present, non food sectors are growing fast and supply chain models are not at all stable (in the food sector, delivery options are clearer). This is therefore a critical moment at which to discover how logistics and supply chain operations are developing, how they might be steered, and with what implications for transport and carbon emissions.

Method: The first step is to find out where and when online non-food shopping occurs (home, work, mobile, etc.), the types of items purchased, how deliveries are scheduled and how this varies with sector and location e.g. urban, sub-urban or rural. To do this we will review existing data on online shopping (Theme 1) and conduct eight focus groups to inform a programme of household interviews (N=90) designed to discover how domestic 'infrastructures' of shopping – including transport and storage - are changing and to record experiences and views of alternative delivery options (to be developed in collaboration with project 2.1). Two in-depth case studies will be developed with different sectors in conjunction with IMRG (the UK Industry Group for e-retail; the British Retail Consortium) and third party operators (Home Delivery Network) to explore alternative scenarios for future system of provision, in terms of product sourcing, stockholding locations, inventory management and transport arrangements over longer distances and for the 'last mile' to the customer. The final stage is to expand the scale of the research to identify the potential impacts of a

sub-set of the most promising lower carbon solutions via a questionnaire survey (N=2000) aimed at a nationally representative sample of households.
Outcome: This project will show how methods and systems of shopping and delivering are changing and how currently fluid systems of provision are evolving. The research will reveal the energy implications of alternative online shopping futures, and assess their societal viability.

3.4 Monitoring and controlling demand

Rationale: Energy and mobility systems managers have an active role in monitoring and controlling flows of energy and of movement through transport systems. Increasingly sophisticated technologies are used to deliver detailed real time knowledge about conditions of various forms, and to remotely set and control key parameters and inputs at scales ranging from those of individual building management through to city wide transport systems. At every level, the managers of these systems have a substantial stock of experience that merits systematic analysis and investigation. Research will show how objectives of energy demand reduction are managed in practice, how strategies are shaped by competing performance goals and expectations, what craft skills, intuition and experimentation are involved; and how developments in on-site microgeneration and energy storage might impact on the real time management of energy supply and demand at different points across the network as a whole.
Method: The research will investigate 8 case studies of local/regional real time energy management within building complexes (retail centres, hospitals, industrial parks), and transport and electricity supply networks, including control rooms of TfL and the Highways Agency. These case studies will involve interviews (N= 24), periods of observation and analysis of system and training documentation. Interviews (N=6) will also be undertaken with management system developers, and with relevant actors in smart grid pilot projects in France (with EDF researchers).
Outcome: This project will document and compare current practices, priorities and challenges of real time demand management, identifying systemic tensions and potential solutions, and feeding results into ongoing experiments and emerging plans for more decentralised systems and 'smarter' grids/methods of managing congestion and flow.

Theme 4: Normality, need and entitlement.

Theme 4 tackles fundamental questions of justice, need and entitlement, doing so in order to generate and inform public policy and national and international debate about how much energy consumption and mobility is required to participate effectively in society and how these needs might change. This feeds in to ongoing work at EDF R&D and the IEA.

4.1 Energy and Justice

Rationale: The goal of reducing current patterns of mobility and energy consumption has to be set alongside the importance of such consumption in achieving a fair and just society. Questions of fuel/energy and mobility poverty are typically addressed as separate topics. As well as analysing how different forms of inequality intersect within and between generations, and how notions and images of need, luxury and excess circulate in public discourse, this research develops methods of conceptualising energy-related rights, including the right to lower carbon living.
Method: The research will a) draw together literature on energy/fuel and mobility poverty, climate justice, equity and entitlement; b) analyse media reporting on selected needs and rights to energy consuming practices (e.g. the right to fly; the meaning of comfort); also tracing the 'career' of the

concept of fuel poverty as it has circulated through consumer advocacy groups and public policy in the UK, France and the EU; c) develop a conceptual framework linking notions of capability[22] to the need for energy services (including mobility) applying this to the UK and French context, and where appropriate to the EU and beyond, and d) use these materials to organise on-line public debates on energy and justice, and a seminar series on the social foundation of energy demand.
Outcome: A critical understanding of tensions between carbon reduction and social equity, a synthesis and analysis of related academic debates, insight into how questions of need, access and entitlement are negotiated in national and international policy, and the initiation and development of wider debate about the nature of demand, for example, through the IEA.

4.2 Beyond elasticities: affording mobility

Rationale: Spending on transport varies more significantly than any other area of household expenditure, currently ranging from £16.40 a week for the lowest income decile to £155 or more for the highest. In addition, the need for mobility is so embedded that spending tends to rise as costs increase.[23] In this context, rising oil prices and the implications of a shift to electric propulsion (which changes the relative unit costs of travelling for those that can afford the initial capital outlay) could have very significant impacts with large distributional implications. This project is designed to evaluate future scenarios in terms of differential affordability, access and mobility justice.
Method: The research is in three stages, first concentrating on household experience. 6 focus groups will be held in each of two areas characterised by good and poor non-car based mobility options, followed by 50 household interviews. Sampling will ensure adequate coverage of five income quintiles. These will allow us to determine forms of transport 'stress' and responses to it. The second stage uses GIS mapping tools to analyse various technology and policy scenarios and present new metrics of transport stress as an input to stage 3 of the research. A further 30 interviews and 3 workshops with policy makers in England, Scotland and Wales will debate present priorities, future scenarios and the concepts of entitlement on which they depend. For example, how far should policy go in providing people with the means to access and use transport?
Outcome: This research will generate new metrics, mapping and insights which better represent the distributional impacts of future transport and energy policies.

4.3 Implicit energy governance

Rationale: What energy is used for, or how energy needs are made, is in part a reflection of how governments shape objectives, investments and ways of providing and working across many different policy domains. It follows that non-energy policies, for example, relating to security, health and safety or consumer choice, can have major implications for energy demand. This exploratory project takes on the challenge of identifying the unintended energy demand consequences of policies in the three areas of health care, the military and higher education. These are three of the largest non-commercial consumers of energy, and as such provide revealing sites in which to develop approaches for tracing the energy and mobility implications of high level shifts in policy agendas over the past 30 years.
Method: We adopt a two pronged method, working with 2 institutions (barracks, hospitals, universities) in each sector to isolate specific areas of energy-use and/or mobility demand that are directly or indirectly attributable to national level policies and regulations (N=30). The history and formation of these non-energy policies will then be examined through documentary analysis, literature review, and interviews with key informants in the Department of Health, MOD and HEFCE (N=15).
Outcome: By showing how non-energy policies promote and justify end use practices the research will reveal non-energy policy options for radically reducing CO_2 emissions. The ultimate aim is to explore ways of using 'non-energy policy' as a means of significantly transforming energy demand.

Theme 5: Integration and application

Projects in Themes 1-4 will provide detailed evidence and understanding of where energy demand is made, how end use practices change and of how these processes might be managed to produce measureable reductions in CO_2 emissions and energy demand. Three cross cutting projects in Theme 5 integrate and synthesise this research, adding value to the programme as a whole (see Figure 1), and working with non-academic partners to test and explore the practical implications of our results for managing major transitions in demand.

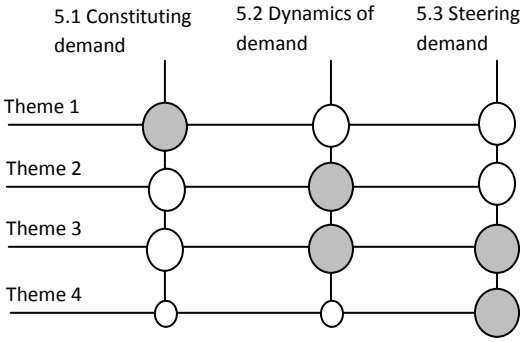


Figure 1: Theme 5 framework

5.1 Constituting Demand

Rationale: This project integrates and evaluates evidence (especially from Themes 1 and 2) of how energy demanding end use practices vary in terms of how they are enacted, by whom, when and where. Particular attention will be paid to detailing the social distribution (in terms of age, class, location) of more and less energy intensive end use practices and characterising forms of societal synchronisation across these practices. This fundamental yet novel work will for the first time provide a map of contemporary demand in the UK organised around end uses practices. Project 5.1 focuses on the practical, policy implications that flow from seeing energy demand as an outcome of social practices that are varied, changing, and only accessible to some. Specific tasks will include producing and promoting new methods of analysing patterns of demand in ways that are relevant to future models and forecasting/scenario building techniques and capable of addressing demand in far more sophisticated and differentiated ways. We will integrate results from Themes 1-4 to deliver a more generic account of how and why areas of energy use and mobility intensify, stabilise and decrease. We will develop an empirically informed analysis of how systems of provision 'constitute' patterns of end use demand, and show how this might be used to reduce carbon emissions. As part of this work we will quantify the carbon and greenhouse gas implications of selected project results, doing so by developing and applying a framework that integrates data from the mobility, energy supply and buildings sectors.

5.2 Dynamics of demand

Rationale: This project integrates results and evidence (especially from Themes 2 and 3) of how energy demand is changed and of how technological innovations (smart grids, electric vehicles, better management and control systems, new methods of organising delivery and logistics) shape and are shaped by innovations in end use practice. Radical reductions in carbon emission will depend on the adaptation, not the total overhauling, of existing systems of provision. We need to know how far such adaptation can go, both socially and in terms of the scope for reconfiguring contemporary systems of energy and mobility provision at different scales. Specific tasks within this project include revealing and comparing visions of future end use practices that are embedded in the diverse strategies and modes of demand management being promoted in plans for decarbonising the energy system. This will allow us evaluate the 'societal robustness' of such scenarios and plans, developing new methods for assessing the relative fixity, flexibility, path dependence, fragility and resilience of existing infrastructures and institutions and of the practices

that depend on them. As part of this work (inspired by recent analysis by the IEA) we will examine the capacity to respond to crises in which demand outstrips supply. Here we will consider historical and contemporary evidence of how end use practices change when communities face prolonged shortfalls in supply and explore the relevance of such experience for the design of appropriately radical carbon reduction strategies. We will work with EDF R&D and TfL to apply the results and insights of our research and learn from real-time initiatives in demand management as they emerge.

5.3 Steering demand

The DEMAND programme (and especially Themes 3 and 4) confronts basic questions about how evolving patterns of energy demand could and should be steered, and by whom. If demand is constituted by social practices, one implication is that purposeful steering involves far more than acting in energy and mobility domains alone. It follows that there are many possible points of intervention. The primary purpose of this integrative project is to identify these forms of influence, critically examining the parts that state and non-state actors can play (singularly and in combination) in shaping energy demand trajectories. This is a necessary step if we are to assess how future escalations in demand might be countered and how effective demand reduction strategies might be fashioned. Reinterpretation of stakeholder interviews and data from Themes 2-4 will allow us to tackle key questions about the governance of energy demand: where does the power to intervene lie, what are the possibilities and limits of partnership and cross-sectoral coordination and what are the practical and political tensions involved in defining, negotiating and moving towards a radically lower carbon society in a context of competing priorities and contemporary inequalities? We will develop and extend concepts of reflexive governance, applying them to transitions in demand and practice, and learning from international experience of ambitious demand management strategies as in Germany and Japan.

Method for projects 5.1-5.3

Projects in theme 5 will adopt and experiment with different forms of co-working including concentrated thematic 'working parties' involving different members of the DEMAND team (including PhDs); developing strategies for embedding results in practice (e.g. with TfL; SCI/TESCO; EDF R&D); capitalising on the potential to draw comparisons between mobility and energy demand in buildings, and between France and the UK (with EDF R&D; DECC); promoting, scaling up and extending our understanding of DEMAND at a European and international level (through the IEA internship and ongoing collaboration with policy advisors), and working with our non-academic club to design, monitor and evaluate initiatives and experiments in end use demand management. Projects in Theme 5 will involve further literature review and desk research, commissioning 'think pieces', collaborating with visiting scholars, undertaking comparative data 'clinics', and developing further statistical analyses and quantification of carbon/energy implications. The intention is to fully exploit the empirical data collected in Themes 1-4, analysing this from different perspectives and points of view.

Outcome: Theme 5 combines research with interaction, innovation and engagement. As such it serves multiple purposes, providing a common point of reference for all DEMAND projects and team members, and a means of ensuring that the research programme is very much more than the sum of its parts.

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