



ESRC Research Group on lifestyles, values and environment

Consuming Carbon

RESOLVE Scenarios to 2030 for UK Household Consumption

**Better late
than never**

**All together
now**

**Over the
edge**

**Trading
woes**

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by Scott Milne

RESOLVE

RESOLVE is the ESRC Research group on Lifestyles, Values and Environment, a novel, cross-disciplinary research collaboration between four separate groups in the University of Surrey: the Centre for Environmental Strategy, the Environmental Psychology Research Group, the Surrey Energy Economics Centre and the Department of Sociology.

Centre for Environmental Strategy (D3), University of Surrey, Guildford, Surrey, GU2 7XH, UK

resolve@surrey.ac.uk

Tel: +44 1483 686689

Fax: +44 1483 686671

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Foreword

Nick Robins, Head, HSBC Climate Change Centre of Excellence

The climate agenda is in clear need of a reboot. The energies that fed into the Copenhagen summit have manifestly dissipated – with the global financial crisis diverting public priorities away from long-term environmental risks back to short-term economic survival. Simultaneously, however, the resource risks confronting the UK have continued to grow, with high food and energy prices contributing to the erosion of living standards, with the prospect of further ‘climate inflation’ in key commodities ahead.

Out of this apparent impasse, a new phase in Britain’s climate strategy is struggling to be born – one that views climate security as the natural product of a healthy economy rather than something engineered through the technocratic internalization of externalities. *Consuming Carbon* is an important step in this process by rooting future trajectories in the realities of the ordinary household. To date, the bulk of serious policy effort has been directed at large-scale supply-side measures, ignoring the demand-side challenge as inherently difficult, political and too dependent on the behaviour of irrational individuals. This is now being partially remedied through the plans for the Green Deal building retrofit initiative. But more needs to be done.

The scenarios sitting at the heart of the report underscore two critical ingredients in the successful adoption of low-carbon lifestyles. The first ingredient is a credible international process that actually helps to build greater confidence at the household level of the need for domestic action - in place of the current arrangement that perpetuates a view that the climate agenda is confined to a continuous cycle of inconclusive summits. The second ingredient is the need to demonstrate that climate security can be achieved *with*, rather than at the expense of, rising standards of living. It is striking that the scenario with the poorest climate performance – *Over the edge* – also has the weakest household expenditure levels as the persistence of a high carbon trajectory ultimately chokes off growth. At a time when real living standards have fallen by the greatest extent for many decades, this conclusion needs to be broadcast far and wide: the traditional path will not only fail to deliver prosperity and growth, but will also underachieve on sustainability.

One theme that would warrant further research is the linkage between household sustainability and capital investment. Our research at HSBC suggests that a third of the global investment needed in the climate economy by 2020 will need to be undertaken by households in decentralized energy, building efficiency and low-carbon vehicles. Looking ahead, it will be critically important to understand how low-carbon capital investment relates to household savings and pensions and to household asset values – and also ensure that the carbon intensity of investment portfolios is reduced so that they do not also suffer from an implosion in value experienced in the *Over the edge* scenario. The time has come for the ‘green consumer’ to give way to the ‘climate investor’.

Executive Summary

As part of the ESRC Research Group on Lifestyles, Values and Environment (RESOLVE) a series of four scenario narratives were developed to explore the carbon intensity of UK household consumption through to 2030. Those narratives are provided here along with a comparative summary of illustrative emissions figures and a series of discussion points.

Each of the scenarios in this report describes a series of global, regional and national developments and associated changes in UK household consumption behaviour over a 20 year period. The narratives begin in 2010 in the aftermath of the global financial crisis, amid associated uncertainties around the strength and the nature of economic recovery. In the period 2015-2020, all four scenarios experience sustained energy and resource price pressures, with subsequent developments unfolding according to the unique assumptions of each scenario.

Better late than never: Little significant change in efforts to tackle emissions up to 2020, when increasing calls for climate action combine with rising fuel and commodity prices to bring things to a crisis point. Out of the crisis, international leaders build consensus on a comprehensive programme of emissions cuts. Although there is little improvement in the carbon intensity of UK lifestyles before the crisis, the securing of a global deal instills a sense of common purpose that encourages proactive behavioural change.

All together now: Voluntary climate action by different countries, including through green job programmes to aid economic recovery, helps to lay the groundwork for a comprehensive and equitable global deal in 2015. The cooperative approach observed at the international level is reflected in the behavioural change undertaken at the household level.

Trading woes: Unilateral climate action by the EU is intended to draw further commitments from other parties, but with no such action forthcoming by 2015, the EU threatens the use of trade measures. After a period of heightened political tensions and economic slowdown, a compromise is reached. The result is a series of bilateral emissions targets that remain insufficient to avoid dangerous climate change. The UK public are cautiously optimistic at first, but without commensurate international action, enthusiasm for pro-environmental behavioural change is weakened.

Over the edge: With little effort on emissions reduction, the global economy is exposed to increasing fuel prices towards 2020. With intensified social pressure to reduce fuel prices, and unable to work cooperatively on establishing an equitable emissions regime, countries instead pursue divergent, often conflicting energy security policies. The persistence of fossil fuel extraction as part of those policies extinguishes any hope of a low carbon transition, and leads to international conflict.

Based on historical trends in UK household consumption emissions, coupled with the unique assumptions of each scenario, a series of emissions trajectories are provided for discussion. By focusing on consumption emissions, which include those embedded in imported goods and services, the illustrative figures provided here suggest that a strong domestic decarbonisation programme, although necessary, will remain insufficient to bring UK household consumption emissions to within sustainable levels unless commensurate action is taken internationally or trade restrictions are applied (note that in *Trading woes*, this latter approach is attempted by Europe, but proves politically unsustainable).

About RESOLVE

RESOLVE is the ESRC Research group on Lifestyles, Values and Environment, a novel, cross-disciplinary research collaboration between four separate groups in the University of Surrey: the Centre for Environmental Strategy, the Environmental Psychology Research Group, the Surrey Energy Economics Centre and the Department of Sociology.

The overall aim of RESOLVE is to develop a robust understanding of the links between lifestyle, societal values and environment. In particular, RESOLVE will work to provide robust, evidence-based advice to policy-makers in the UK and elsewhere who are seeking to understand and to influence the behaviours and practices of 'energy consumers'.

The Climate Change Act commits the UK to an 80% reduction in greenhouse gas emissions by 2050. It's fanciful to suppose that such 'deep' cuts in emissions can be achieved without impacting on people's lives and lifestyles. Even if this only means that people need to insulate their homes, use more efficient appliances, buy low-energy light bulbs, drive a little less or walk a little more, it implies changes in how people live, eat, shop, work, invest and spend their leisure time.

Since RESOLVE was launched in 2006, the challenge of sustainable living has become an increasingly important aspect of debates about the environment – in particular in relation to climate change. Progress in understanding the technical, social and behavioural demands of low-carbon living has gone hand in hand with burgeoning media and policy interest in the subject. Policy commitments to carbon targets are all very well. But what do these targets mean for people's lives? Which areas of our lives will need to change? How easy will this be? How effective are policy interventions likely to be? Which forms of governance are most successful?

These questions have been thrown into an even sharper relief through the recession. It is still unclear exactly what the long-term impact of this will be in terms of sustainable living. Will people adopt a more frugal approach? Will this frugality spill over into more sustainable ways of living? Could it last beyond the recession – given appropriate policy support? Will people's longer term aspirations and attitudes change?

None of these questions is easy to answer, particularly in the context of fast-moving politics and a changing economic climate. But RESOLVE is ideally placed to ground policy debates about sustainable lifestyles in sound scientific research and to build realistic visions for a low-carbon society.

About this report

The scenarios described in this report were researched and written by Scott Milne, as the culmination of the research for his PhD, funded by the ESRC and based within RESOLVE. The scenario narratives are accompanied by quantitative expenditure and emissions pathways, full details of which are available in a supplementary report¹. In addition, the methodology adopted for the study is described in the PhD thesis².

1 Milne, S., (2011) "Consuming Carbon Supplementary Data: RESOLVE Scenarios to 2030 for UK Household Consumption", RESOLVE Working Paper 15-11, ISSN 1755-7259.

2 Milne, S., (2011) "Carbon intensity of UK Household Consumption: Scenarios to 2030", doctoral thesis, University of Surrey, Guildford, UK.

Introduction

Any analysis of future UK household consumption emissions faces profound uncertainty on a number of fronts. Among the range of issues relevant to the study, three factors in particular emerged as critical to this work: the energy, economic and environmental outlooks. The speed and scale of developments surrounding these three issues, even in isolation, would imply significant stresses and shocks for UK households. Taken together, the challenge seems formidable. It seems only reasonable to suggest that society is faced with an inflection point, either sooner by design or later by necessity, in relation to material goods and services and the manner of their production. Before considering the impacts in relation to lifestyles, a brief review of the key concerns around these three uncertainties is required.

A recent report on global oil depletion by the UK Energy Research Centre (UKERC) concluded that conventional oil production is likely to peak before 2030, with a significant risk that this may happen before 2020. The chief economist to the International Energy Agency (IEA), Fatih Birol, has also stated that demand for oil could outstrip supply by 2020. The dynamics of oil depletion are complex, including uncertainties over: the true extent of conventional reserves, levels of investment in exploration, the potential of non-conventional supplies, domestic consumption by oil producers and the desire for energy security among oil importers. It is nevertheless clear that a decline in oil availability presents a significant medium to long term risk for the UK economy.

The economic events that have unfolded since July 2007 have been described as the worst financial crisis since the Great Depression. The crisis has resulted in governments taking unprecedented steps to prevent a collapse of the global financial sector, including the nationalisation of banks, and wholesale bailouts of nation states in Europe. A drop in the value of housing, increased unemployment and shortage of credit have all contributed to the economic uncertainty for UK households. At the time of writing (summer 2011), significant uncertainty around the strength of the recovery has led to renewed fears of a double dip recession.

In the midst of this economic crisis, global leaders were also tasked with securing a deal at the Copenhagen climate summit in December 2009. In the end, the UNFCCC negotiating process barely survived, no legally binding deal was achieved, and the voluntary commitments that were announced remained well short of the levels necessary to avoid the risk of catastrophic climate change. One year on, in Cancun, the climate talks achieved little more than a political agreement to continue holding talks, with little if any further improvement on commitments by individual member states. In addition to the political and economic uncertainties around an international agreement, the extreme weather events of 2010 served as a reminder of the potential direct impacts of climate change, even in the short term, as a result of increased average global temperatures.

In relation to such overarching global uncertainties, behaviour change at the individual level may seem trivial. Besides, many of the technological innovations that would be required for a low carbon transition will occur out of sight of consumers in their day-to-day lives, e.g. supply side innovations in electricity supply, new agricultural methods for low carbon food production etc. However, in addressing the overall challenge, significant change may also be required on the part of citizens and consumers more directly. In many cases the changes may be subtle, e.g. where economic incentives influence consumption patterns towards less energy intensive versions of familiar goods and services. In other cases, more radical behaviour change may be called for, such as modal shifts in transport use, installation of micro-generation technologies or retraining for green collar jobs.

Ultimately, it may be that individuals' values and behaviours hold the key to ensuring that a low carbon transition can be made in an orderly and proactive fashion, rather than a disorderly and reactive one.

Therefore, while global uncertainties should certainly frame the landscape of change to 2030, and technological innovations will play an enormous role in the way society responds to those uncertainties, these should not be treated in a deterministic way, independent of the will of individuals.

This study therefore aims to explore the opportunities and constraints for householders in the UK in shaping and responding to this future. To achieve this, the RESOLVE scenarios have been developed to explore a range of social, technological, economic and political outcomes over the period to 2030. In each case, a series of global, regional and national developments are described, with associated changes in UK household consumption. Before considering these futures though, some context is provided through an examination of historical UK emissions.

UK emissions accounting

To understand the trajectory of UK household consumption emissions, and to place these in the context of emissions reduction targets established by government, it is necessary to distinguish between two emissions accounting perspectives. The method used by government to assess historical emissions levels and to establish legally-binding targets is known as the **production perspective**. This method counts emissions arising from all goods and services produced within the UK, regardless of whether these are consumed domestically or exported for consumption abroad. With manufacturing and other energy intensive industries having shifted away from the UK in recent decades, this production perspective has accordingly shown a reduction in UK emissions since 1990. However, this approach ignores emissions from goods and services that must now be imported – perhaps from countries with less energy efficient manufacturing industries, and requiring increased transportation to reach the UK market.

The alternative approach is to assess emissions from a **consumption perspective**. In this approach, exported goods and services are excluded from the accounting while emissions from imported goods and services are attributed to the UK. In other words, it is the consumers of goods and services who are deemed responsible for any associated emissions, regardless of where they are produced. Following a consumption approach, emissions in the UK have actually been increasing since 1990.

While the production perspective is employed for global accounting of emissions as part of the Kyoto Protocol, it has long been argued that the consumption perspective represents a more egalitarian approach. Indeed, in 2009 the newly appointed Chief Scientist at the Department of Energy and Climate Change (DECC) argued that apparent reductions in UK emissions since 1990 were an illusion, failing to account for embedded emissions in imported goods and services.

Production emissions targets

The UK Government passed the world's first legally binding framework on climate change with the Climate Change Act 2008. The newly formed Committee on Climate Change (CCC) then recommended a revised 2020 emissions reduction target of 34% on 1990 levels, which was accepted by Government. The CCC also proposed that in the event of a global deal on emissions, the UK should increase its target to 42% by 2020, and 90% by 2050. However, the failure to secure a sufficiently robust deal at Copenhagen meant the UK target remained unchanged through 2010. More recently, the government adopted the proposals from the CCC for the fourth carbon budget, with a target of 50% by 2025 (averaged over 2023-2027).

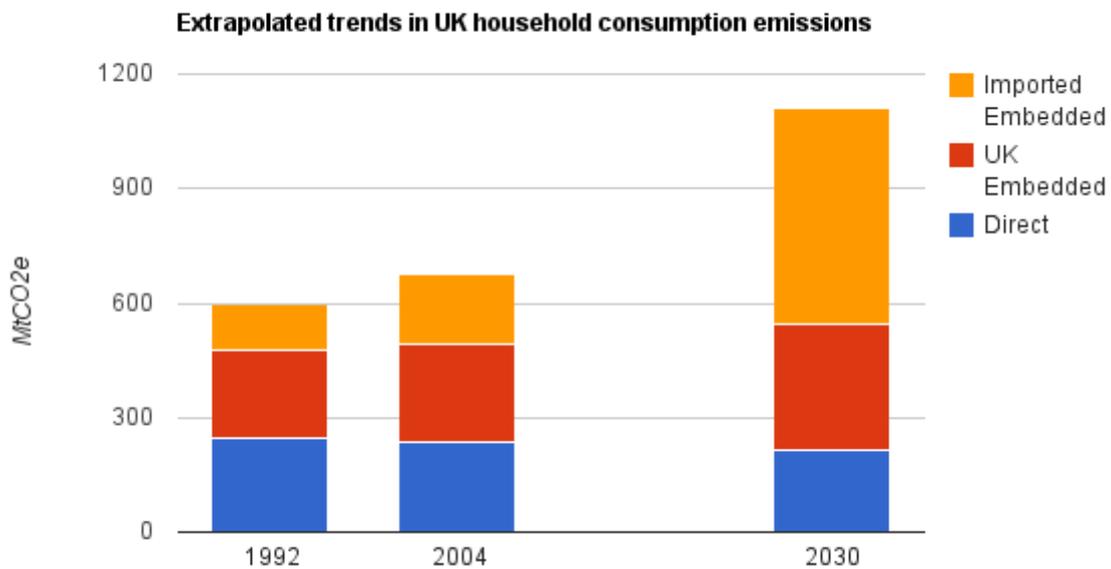
The recommendations of the CCC and their adoption by government imply significant changes for UK producers over the coming decades, and certainly for a study exploring UK *production* emissions

through to 2030, the CCC recommendations might act as a powerful framework through which to develop alternative visions of implementation. It also seems clear that a production perspective will continue to dominate international accounting of emissions for the foreseeable future. Nevertheless, for a study concerned with the carbon intensity of UK lifestyles as opposed to UK industry, it is necessary to adopt a consumption perspective. Specifically, this study focuses on UK household consumption emissions, disregarding emissions associated with government consumption and investment.

Consumption emissions trajectory

One of the key concerns raised in the work of RESOLVE has been the growing gap between emissions measured from a production versus consumption perspective, the so-called CO₂ trade balance. The decarbonisation of the UK economy over the last 20 years has been due in large part to the 'dash for gas' and the offshoring of heavy industry. Households have meanwhile continued to purchase more goods and services, now increasingly produced abroad.

Taking historical trends identified in RESOLVE modelling work, we can examine changes in UK household consumption emissions since 1990 by dividing these into three categories: those associated with direct energy use (electricity, gas, vehicle fuels etc); those embedded in goods and services produced in the UK; and those embedded in goods and services imported from overseas. The chart below shows the extrapolation of those historical trends through to 2030.



The results from this simple extrapolation imply that even *without* a domestic decarbonisation programme, emissions attributable to the UK (direct and UK embedded emissions) would fall as a share of total UK household emissions to 50%. It may be argued that only so much of UK goods and services could really be 'economically' offshored, and that accordingly a slowing of the growth for imported emissions should take place over time. Nevertheless, it can be countered that if a domestic decarbonisation programme *were* to be introduced, direct (and UK embedded) emissions could fall dramatically. Thus, although the result would be lower absolute emissions, the proportion of the

remaining emissions falling within the jurisdiction of the UK and therefore amenable to UK policy intervention, would be lower.

These illustrative calculations emphasise the significance of the uncertainties explored in this study, described in the next section. How these uncertainties might play out will have implications for policymakers as well as for households and individuals themselves, in understanding the global context in which domestic and household behaviour change is situated. If things turn out one way, it may be that consumption emissions fall into line with production emissions, obviating the need for a redundant 'shadow' accounting method. Alternately, as the calculations and scenarios imply, the gap between consumption and production emissions may widen further still, perhaps reinforcing the need for a complementary if not competing approach to the official accounting mechanism.

Scenario framework

The scenario framework below consists of two axes: the effectiveness of the international emissions regime, and the timing of UK (and EU) action in relation to any low carbon transition. In addition to these two dimensions, a third factor is introduced over time: a period of rising fossil fuel and commodity prices from 2015-2020. In effect, the four scenarios are 'tested' by those price pressures, with the responses varying according to the wider social, technological, economic and political conditions specified in each case.

The two scenarios characterised by an early transition involve an initial strengthening of UK (and European) policy for a low carbon economy, with subsequent developments characterised by the willingness of the international community to take commensurate action.

The late transition scenarios reflect inaction in the short term, followed by markedly different responses to fossil fuel and commodity price pressures from 2015-2020. Summaries of the four scenarios are provided over the page.



Scenario summaries

Better late than never: Little significant change in efforts to tackle emissions up to 2020, when increasing calls for climate action combine with rising fuel and commodity prices to bring things to a crisis point. Out of the crisis, international leaders build consensus on a comprehensive programme of emissions cuts. Although there is little improvement in the carbon intensity of UK lifestyles before the crisis, the securing of a global deal instills a sense of common purpose that encourages proactive behavioural change.

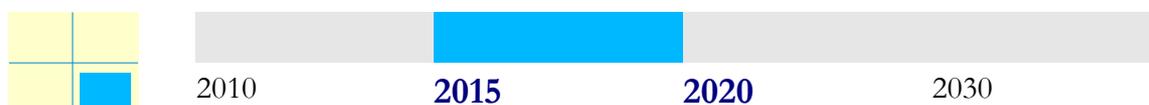
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Over the edge: With little effort on emissions reduction, the global economy is exposed to increasing fuel prices towards 2020. With intensified social pressure to reduce fuel prices, and unable to work cooperatively on establishing an equitable emissions regime, countries instead pursue divergent, often conflicting energy security policies. The persistence of fossil fuel extraction as part of those policies extinguishes any hope of a low carbon transition, and leads to international conflict.

Reading the narratives

The scenarios follow a consistent format to enable cross-comparison. In each case, the narratives have been broken down into three time periods, describing events unfolding from 2010-2015, 2015-2020, 2020-2030. A timeline feature identifies the relevant scenario and time period under discussion:



Key developments among the various factors of interest are then discussed as follows:



Global factors. These include social, political and economic developments at the international level, e.g. an international emissions regime, trade relations, or particular climate action taken by the US, EU and China.



UK Factors. These include social, political and economic developments at the national level, such as environmental policy measures, financial incentives, social pressures and media coverage.



At Home. Describes consumption activities around the home, including use of energy for heating and appliances. As with all the consumption categories, outcomes described here include behavioural changes resulting from price signals as well as those influenced by non-economic factors.



The Food We Eat. Relates outcomes in terms of dietary changes, food waste etc. As with the other categories, the carbon intensity of household consumption can be impacted by supply/production processes as well as behavioural change. Any changes in carbon intensity due to production changes are therefore also treated as outcomes.



Getting Around. Includes day-to-day transport use for commuting, visiting, leisure practices and so on. The category covers private car use as well as public transport, walking and cycling.



Getting Away. Relates exclusively to aviation for tourism. Whereas the other three are composite categories comprising a series of activities, the identification of aviation as a category in its own right hints at the significance of this activity in two ways: the central importance of foreign travel as an aspiration in peoples lives, but also as a recognition of the environmental impact of this activity.

Quantification

At the end of each scenario narrative, two charts are provided summarising total UK household expenditure and emissions over the 20 year period of the scenario. The figures are broken down into 16 categories of goods and services, with direct emissions categories grouped at the bottom, and embedded emissions categories stacked above. For a more detailed description of this categorisation, and a more thorough examination of the illustrative figures, (i.e. a full breakdown of the assumptions used in each variable, for each category, across each time period) see the Supplementary Data³.

³ Milne, S., (2011) "Consuming Carbon Supplementary Data: RESOLVE Scenarios to 2030 for UK Household Consumption", RESOLVE Working Paper 15-11, ISSN 1755-7259



Little significant change in efforts to tackle emissions up to 2020, when increasing calls for climate action combine with rising fuel and commodity prices to bring things to a crisis point. Out of the crisis, international leaders build consensus on a comprehensive programme of emissions cuts. Although there is little improvement in the carbon intensity of UK lifestyles before the crisis, the securing of a global deal instills a sense of common purpose that encourages proactive behavioural change.



The lack of a decisive outcome from the Copenhagen summit leads to a general slowing down of efforts to achieve a substantive international agreement on climate change.

Concerns turn towards the economy and the precarious recovery from the global recession of 2008.

As a result of the global slump in demand, commodity prices including fossil fuels remain below the historically high levels seen leading up to the recession. Consequently, there are few substantial incentives to encourage greater energy or resource efficiency, either by producers of goods and services or by households directly.

In developed countries, mainstream media coverage continues to represent climate science as something contested, and the solutions expensive, ensuring the marginalisation of climate activists and campaigns. In those countries worst affected by extreme weather events, there are continued (and increasing) calls for developed countries to act on climate change.



At home, the government renege on some of the environmental policies of their predecessors, while attempting to establish a green agenda of their own. On balance though, environmental policies become another victim of the programme of cuts in public spending.

For most UK households, employment remains the primary concern during a period of slow recovery.

The negative portrayal of climate science in parts of the UK mainstream media intensifies, with increasing attacks on leading climate scientists and institutes detracting from the science itself.

Meanwhile, other parts of the UK media continue to report on climate change in accordance with the mainstream scientific community. For these outlets, the extreme climate variability of recent years acts as a stark warning of the need for radical change.

Whilst the environmental movement grows in number and improves its outreach capacity, a largely ambivalent public refuse to commit to serious behavioural changes or support political action.



A lack of government incentives and subsidies combined with short term financial worries keep capital expenditure on home insulation and micro-generation at a low level. Although consumers report energy efficiency as being an important consideration when purchasing new appliances, actual purchasing behaviour points to the prevalence of cheap, low energy efficiency products.



The absence of economic or behavioural incentives means there is no meaningful change in food consumption patterns.



Financial constraints prevent significant uptake of new, more efficient vehicles. Meanwhile, lack of incentives means no significant reduction in vehicle use, e.g through shorter trips or car sharing.



The absence of effective policy measures to tackle the environmental cost of aviation leads to an increase in flights, with demand recovering sharply from a drop during the economic crisis of 2008.



From 2015, rising global demand leads to significant increases in prices of commodities and fuels. Through to 2020, this sustained price pressure leads to slower growth in the global economy.

Concerns about unrelenting fuel prices crystallise into two distinct factions: those calling for short term action (lowering fuel taxes), and those attaching themselves to a growing and increasingly coordinated environmental lobby, calling for a rapid transition away from dependence on fossil fuels.

These social movements are mirrored politically, with world governments and their opposition parties grappling with these competing interests.

By 2020 the issue remains unresolved, but the impact on the global economy combined with increasing social unrest means that action becomes inevitable. International talks are scheduled, sparking the largest, most coordinated environmental campaign to date.



In the UK, as elsewhere, increasing fuel prices put pressure on household expenditure. Unable to make an immediate transition away from fossil fuels in the absence of appropriate government support, households are forced to curtail expenditure on other goods and services.

The slowing of the economy towards 2020, and the associated impact on incomes, leads to increasing dissatisfaction with government and a political crisis.

The motoring lobby campaigns vigorously for reduced taxes on vehicle fuels, elements of the energy sector campaign for a relaxation of environmental targets. Meanwhile other players in the transport and energy sectors call for subsidies to support investment in public transport and low carbon energy sources respectively. These competing industry forces form alliances with social movements in an ideological conflict that reflects the global crisis as a whole.

Although modest steps are taken towards emissions reductions, and the economic slowdown inevitably results in less economic activity, it also has a significant impact in delaying low carbon investment in the private sector. There is a gradual realisation that emissions reduction targets for 2020 will not be achieved.

Going into international negotiations in 2020, the UK government comes under immense pressure from both sides of the debate, as opposition parties wait to take full advantage of any public dissatisfaction arising from the talks.



While some basic energy efficiency measures are adopted, lack of robust policy measures and capital funding for retrofit leaves most households exposed to higher fuel prices. Those increases in fuel prices mean that electricity and gas bills take up an ever larger share of household expenditure through this period.



Food prices are similarly affected by global demand (and by higher fuel costs). Unlike electricity and gas though, households are able to adapt by shifting expenditure from high-end, quality food to more affordable value products.

Regardless of a shift in quality, the broad footprint of food purchasing hardly changes, with no transformation of attitudes with respect to meat consumption or local sourcing, and little progress on the reduction of food waste.



A significant rise in vehicle fuel prices means an increasing proportion of households' disposable income is spent on petrol/diesel. Despite continued price pressures, only a gradual shift in transport behaviour is observed over the period, with some households beginning to cycle, car share etc. as they increasingly identify with the sustainability movement.



Increasing fuel costs feed through to flight ticket prices. Still, in the absence of any policy measures or significant behaviour change, growth in household disposable income means that increased costs can only slow the growth in aviation, rather than stop it.



The international summit of 2020 comes at a time of crisis in the global market, with unprecedented demand for fuels and commodities.

In developed countries, there are concerns about the impact of high prices on economic growth, and the viability of a business as usual approach for the long term.

In developing countries the impact has been more severely felt, with lack of sufficient food and fuel supplies leading directly to conflict and humanitarian disaster.

In response to the crisis, leaders at the summit manage to agree on a programme of measures including a global emissions trajectory peaking by 2030 and falling substantially by 2050. Developed countries commit to stringent domestic cuts and an assurance of support for developing nations via low carbon technology transfer and preferential trade agreements with countries implementing decarbonisation programmes.



In accordance with its international commitments, Europe and the UK pass climate and energy legislation aimed at substantial cuts by 2050, with a programme of short term measures towards interim 2030 targets.

In the UK, government rapidly enacts legislation drafted in anticipation of a successful international deal. Funding is made available for a suite of decarbonisation programmes, while financial support mechanisms are established – for households and industry – to encourage take up of low carbon technologies.

The success of the sustainable development movement inevitably signals the defeat of the motoring lobby in its demands for vehicle fuel subsidies. Instead, government signals a long term commitment to the diversification of the private vehicle fleet, with strict targets for manufacturers on electric, hybrid and flexifuels vehicles.

A commitment to low carbon public transport, including substantial seed funding, raises the prospect of a long term resurgence, attracting further private sector investment. Nevertheless, the nature of the industry means that change is slow to materialise in the short term.



A series of measures are aimed at reducing gas consumption. A nationwide domestic retrofit programme initially focuses on the most vulnerable households: older people and low income families in the most inefficient buildings. The programme includes insulation, solar water heating and micro-renewables where appropriate, at no cost to those households.

After the first few years, the programme scales up sufficiently to be rolled out beyond those priority groups, with financial mechanisms in place to ensure capital costs are paid through savings in bills, rather than upfront investment.

Community level micro-generation schemes, including wind, small-scale hydro and biomass with district heating, contribute to the decarbonisation of electricity while bringing further reductions in gas use. These schemes are co-funded by central and local government, private operating companies, and local residents who benefit from price guarantees.



In a collective push to reduce food waste, government, food retailers and NGOs work together to raise awareness and provide information and tools for better food planning and storage, with reasonable success over the period.

Growing awareness of the impact of food production leads to a slight reduction in meat and dairy consumption, and a drive on the part of producers to reduce that industry's environmental impact.

Introduction of mandatory carbon labelling for food leads to further consumer behaviour change.



There is a general expectation that vehicle fuel prices are likely to be driven higher over the period, leading to significant shifts in behaviour.

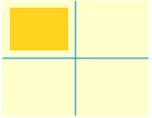
Purchase of fuel efficient vehicles gathers apace, while government commits to more rapid deployment of electric vehicle charging infrastructure, sparking substantial growth in electric vehicle sales and signalling the beginning of a gradual shift away from liquid fossil fuels.

Equally significant is the reduction in single person car journeys, including through increased car-sharing, aided by innovations in communication technologies that allow more effective coordination between networks of friends and colleagues.

Public transport use begins to increase. The gradual shift away from cars and onto trains and buses, results in a less carbon intensive transport sector overall, although aviation continues to play an ever greater part.



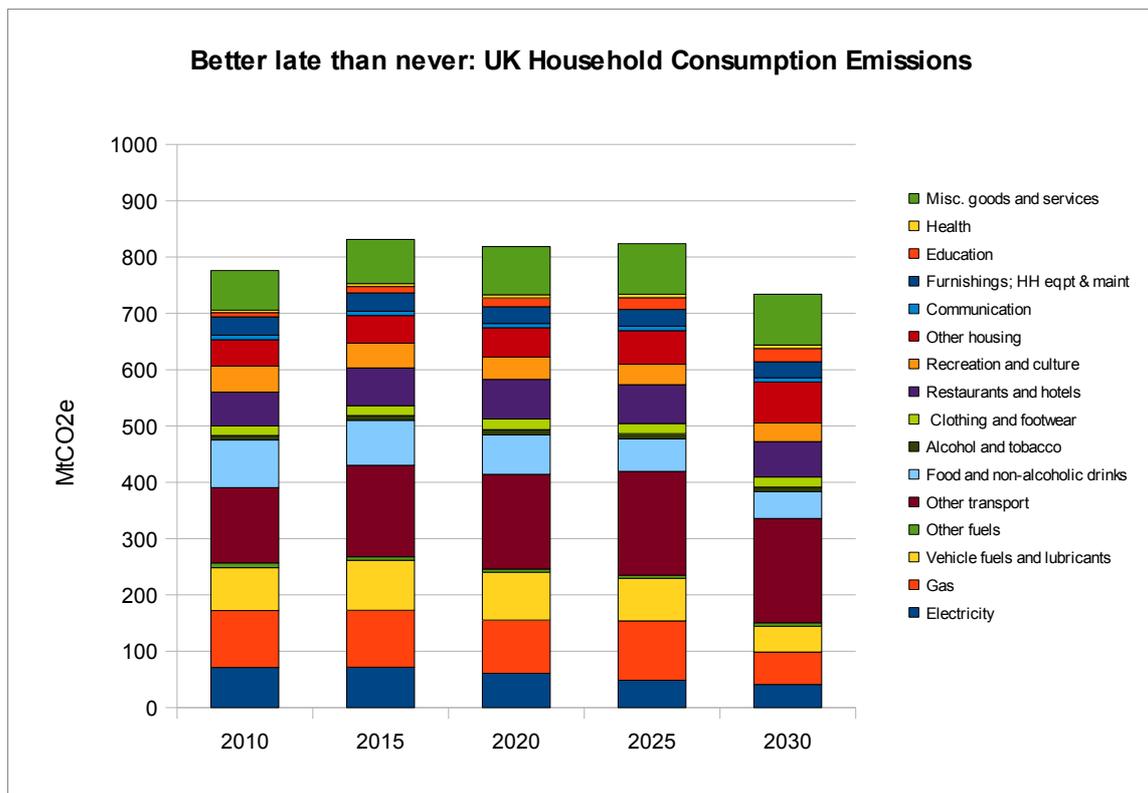
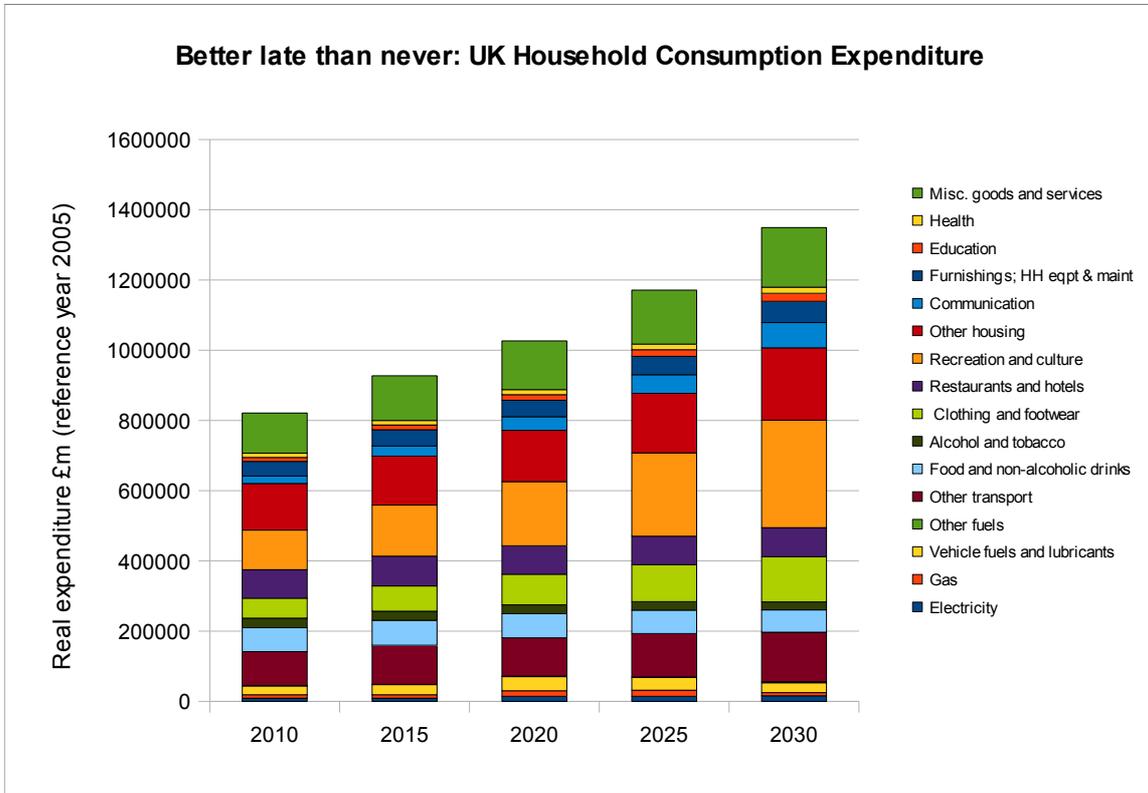
With rising aviation fuel costs leading to higher ticket prices, some families opt for 'staycations'. Nevertheless, increasing disposable incomes ensure that many people remain ready and willing to pay higher prices to ensure regular foreign holidays, meaning growth in aviation is only curbed so far, and is somewhat offset by increased road/rail/bus travel.



2010

2030

Expenditure and Emissions Summary





Voluntary climate action by different countries, including through green job programmes to aid economic recovery, helps to lay the groundwork for a comprehensive and equitable global deal in 2015. The cooperative approach observed at the international level is reflected in the behavioural change undertaken at the household level.



The perceived failure of the Copenhagen summit leads to a period of soul searching among activists, policy makers and climate scientists, and while the UNFCCC process continues, with regular meetings and summits, there is no great hope of this process delivering any substantial deal in the short term.

A slow recovery from the economic crisis of 2008 ensures that jobs remain the central concern for developed countries.

Sustainability advocates pursue a localised, participatory approach to developing positive visions of a low carbon future. Gradually, these groups build support for a green recovery campaign, outlining how a green job creation programme can result in a 'triple win' for economic, environmental and social concerns.

While mainstream media remains a complex terrain in terms of climate science reporting, effective public communication by a 'transition alliance' manages to engineer a shift in column inches towards an emerging positive outlook, particularly around a green economic recovery.

Meanwhile, the EU improves its emissions reduction target to 30% on 1990 levels by 2020.

In the US, despite lack of progress in establishing climate legislation, action begins at the sub-national level with some states establishing programmes for green jobs, emissions trading, and sector-by-sector industrial efficiency targets.

Continuing along a high growth trajectory, China announces a series of ambitious industrial carbon intensity targets.



In the UK, amid the public spending cuts announced in 2010, there is concern that a number of environmental initiatives may be dropped.

As part of a global alliance, activist groups in the UK renew strategies for public engagement, with a focus on green jobs for a sustainable recovery. Allied with trade unions and social justice campaigners, environmental groups attract considerable support for their green jobs agenda.

The UK media seek to capitalise on public anxieties around the recovery, with many spearheading their own campaigns for green jobs, giving a platform to those concerned about the possible impact of proposed spending cuts.

Coordinated protests and strike action puts significant pressure on the government to abandon spending cuts, including on green initiatives.

Citing a desire to lead on emissions reductions within Europe, the UK government responds to improved EU-wide targets with an ambitious emissions reduction target of 42% by 2020, on 1990 levels. In light of the revised target, the government announces a reorientation of public spending priorities, with some ringfenced spending for emissions reduction initiatives, and measures to boost green jobs.

Government launches the green bank to coordinate low carbon investment. Although funds are initially low due to the slow recovery, priority is given to job training programmes for retrofitting, and investment for wind turbine manufacture.

A national retrofit schedule is published, in preparation for a roll out across the most vulnerable households. Measures are also put in place to galvanise neighbouring private households to act collectively in adopting retrofit measures, with a pool of money made available for a range of insulation options to reduce energy demand, and installation of renewables for electricity and heat generation.



Changes to the tax structure around private transport are announced, intended to incentivise more fuel efficient vehicles.

The emergence of a more positive vision of transition leads to more favourable public attitudes on climate action. Still, a gap remains between commitment and action as many households remain unclear as to the most effective action to take.

Having succeeded in persuading their own decision makers to lead on the strengthening of binding targets, UK environmental groups are joined by the general public in calling for government to insist this example is followed internationally.



Exploiting the low hanging fruit of energy efficiency and conservation ensures the EU is on track with voluntary emissions reductions towards the end of this period.

In the US, progress by 'early adopter' states leads to wider adoption of industry targets and sub-national emissions schemes, with steps taken towards a link up with the EU, putting pressure on the US government for implementation at the national level.

In China, industry presses ahead with efficiency measures, in line with sectoral targets.

A global alliance of sustainability advocates gains momentum, citing various early successes in the EU, parts of the US, and in China as evidence of the viability of low carbon development. The alliance calls for global leaders to commit to further action in the form of an international legally binding agreement.

Ahead of a global summit in 2015, two possible outcomes begin to emerge. With the EU, US and China pursuing their own unique strategies for low carbon development, the cementing of these commitments under a unified emissions regime seems credible. Nevertheless, there are fears that without such a binding regime, these distinct approaches may come to be seen as competitive rather than complementary, with the threat of trade measures being used to protect key industries in each region.



Although slowly at first, household energy management shows some improvement over the period, reducing demand for electricity and gas. This is aided in part by publicity around the national roll out of smart meters and energy display devices, although coverage over this period remains low.

Financial incentives for private households to adopt retrofit and micro-generation leads to increased adoption of such technologies, although the initial funds are limited. A government scheme to retrofit the most vulnerable households begins to unfold in parallel. However, starting from such a small base, the initial success of these schemes is more symbolic than substantive.

As part of an improved EU target, increased energy efficiency requirements for electrical appliances leads to higher expenditure on these items, but in the short term there is no significant reduction in household electricity consumption resulting from these measures.



As part of a positive vision for a sustainable transition, environmental groups promote low carbon cuisine, with celebrity and retail endorsement, beginning a shift in attitudes on food, but little immediate reduction in the carbon intensity of food production.

Increasingly, households attempt to grow some of their own food, with results initially failing to match enthusiasm. Nevertheless, local support networks ensure persistence and the development of knowledge and skills.

Households become increasingly engaged in the need to reduce food waste and some progress is made in this regard.



Overall expenditure on new vehicles remains constrained by the slow recovery at first, although changes to pricing mean that fuel efficient models become relatively more popular. Demand for electric vehicles outstrips their modest supply, with hybrid vehicles securing a greater share of the market over this period.

The shift in environmental attitudes leads to a modest change in travel behaviour, with a slight increase in walking and cycling for short journeys and informal car sharing.



After a dip during the recession, aviation begins to grow again with foreign holiday travel proving a particularly difficult area in terms of pro-environmental behaviour change. Although aviation is brought into the EU Emissions Trading Scheme from 2012, the generous provision of permits allows the industry to continue largely as before.



Ahead of the 2015 summit, a global sustainability alliance campaigns for a positive, ambitious and equitable outcome. The movement capitalises on the international participation in visioning projects to demonstrate the widespread grassroots support for a low carbon future. The co-option of leading thinkers, business leaders and decision-makers reinforces the case for a successful outcome, putting further pressure on negotiators to deliver.

The successful performance by early adopters, concern about the high costs of a carbon intensive pathway and the implications of failure in terms of trade relations, all contribute to a successful summit outcome. Developed countries establish a series of ambitious emissions reduction targets for 2030, 2040 and 2050.

A revitalised UNFCCC takes on a monitoring and evaluation role in relation to carbon trading schemes and emissions reporting, with developing nations committing to deeper transparency in addition to further efficiency targets. Technology transfer agreements offer significant opportunities to the least developed countries.

Despite efficiency gains, rising global demand leads to higher prices of commodities and fuels, amid expectations that this trend will be sustained.



In the UK, the signing of an international agreement reinforces business certainty, most immediately noticeable through a surge of interest by large investors, including pension funds, unlocking much needed funding for a series of large-scale infrastructural investments through the green bank.

Despite teething problems, the retrofit of vulnerable households begins to deliver steady results, expanding coverage steadily through this period. The financing scheme for retrofit of private households proves extremely popular, but progress is limited by budgetary constraints, with the scheme being oversubscribed each year.

Decarbonisation of electricity generation continues at a reasonable pace, but a serious step change is required to meet expected future demand as a result of electrification of transport and heat.

Additional funding for the green bank is announced, with support for smart grid, high speed rail and electric vehicle charging technologies. The institution also launches a series of products aimed at attracting capital from individuals and community groups. These products prove popular, attracting funds away from high street banks, and prompting those institutions to offer similar product ranges of their own. An active customer base increasingly influences project funding, leading to a diversification of low carbon investments.

Small and medium enterprises are some of the beneficiaries of that diversification, as a revival of local agriculture and manufacturing is promoted against a backdrop of anticipated higher costs for overseas goods.



The deployment of smart meters and energy display devices continues, with the aim of covering every household by 2020. The devices contribute to a small reduction in demand although advocates suggest that advanced features such as tariffs allowing remote control of appliances are essential to deliver further savings and to assist in load balancing.

Demand for private retrofit grows substantially over this period, with financial support remaining oversubscribed despite increases in funding. A national roll out of retrofit solutions across vulnerable households remains on track, contributing to reductions in fuel consumption and fuel poverty.

Improvements in energy efficiency requirements for electrical appliances continue to have a small impact on electricity consumption, although efficiency gains are somewhat offset due to an increase in the average size of televisions, fridges etc.



Initiatives aimed at promoting a low carbon diet lead to increased awareness of the environmental impact of food production, and significant attitudinal change towards low impact food. Still, the diversity of ethical considerations means that 'low carbon' isn't always the primary target of voluntary changes in food purchasing. Meanwhile, the improved EU emissions target has led to stronger measures to reduce GHGs arising from food production, reflected in the increased price of carbon intensive food products. Arguably, these price signals are proving more effective in shifting food purchasing towards lower carbon items, and the international emissions regime is widely expected to have a further impact in this regard.

The persistence of households attempting to grow their own food begins to pay off, with a steady build up of knowledge and skills leading to more successful yields each year, encouraging further participation. Support networks blossom, with some crystallising into small-scale community farming ventures.

Efforts to tackle food waste prove popular at a time when food prices are rising.



With increased financial backing for charging infrastructure, and with manufacturers having gradually scaled up production, sales of plug-in hybrid and all electric vehicles climb rapidly. Unable to match the fuel economy of EV/hybrid models, and with pricing trends changing irrevocably against them, sales of traditional internal combustion engine vehicles begin to give ground. Nevertheless, these traditional vehicles still account for the majority of new car sales in 2020, and continue to dominate the existing vehicle fleet.

Despite the persistence of private car ownership, a significant rise in vehicle fuel prices leads to a reduction in passenger miles. These price pressures are added to by changing attitudes towards transport, with a shift towards walking/cycling for short journeys, increased public transport use, and the innovative use of communication technologies in support of car share and car pool networks.



As part of the international agreement established in 2015, strict emissions targets are to be applied across the aviation industry from 2020, with a carbon trading mechanism that will increase costs but allow growth for the foreseeable future.

Already, increasing fuel prices have slowed the growth in aviation, but with increasing disposable incomes and foreign travel remaining an important aspiration for many households, it seems unlikely that behaviour change alone will be sufficient to reduce consumption.



Following a sustained period of increased global demand, there are significant pressures on global prices of fuels and commodities. This pressure has been alleviated somewhat by global developments on energy efficiency, preventing a full-scale crisis. Nevertheless, ongoing improvements in energy and resource efficiency are called for to reduce further impacts, particularly on the world's poorest nations.

The scarcity of fossil fuels and the incremental impacts of carbon pricing provide further stimulus for developed countries in their efforts to decarbonise. The burst of activity around low carbon development brings price pressures of its own, although these begin to stabilise over the course of the period.

With increasing pressure to reduce emissions from transportation, countries are required to balance the drive towards specialisation with the need for more localised production. As a result, economies become increasingly diversified.



The UK economy enters the 2020s with domestic emissions on a strong downward trajectory. The resurgence of the agriculture and manufacturing sectors, whilst contributing to that reduction in emissions in many ways, also brings some emissions back 'onshore' by displacing production of goods imported from overseas. Whilst positive from a global emissions perspective, this trend puts an increased emphasis on the need for more strategic economic development if these industries are to develop amid increasingly stringent emissions targets.

By 2020, involvement by mainstream society in the articulation of a sustainable future has ensured that low carbon development is no longer seen as a constraint, but rather as something positive and constructive. Although the visions themselves remain diverse, an underlying commitment to the basic principles of participation and fairness ensure that the transition is viewed positively and carried forward proactively by the majority of individuals and communities.

Through this period, the drive for carbon reductions brings further diversification of the economy. The resurgence of domestic production in agriculture and manufacturing coincides with increased efforts by all sectors of the economy to identify energy savings through improved industrial ecology, maximising the reuse of energy and resources, whilst minimising waste. This leads to innovative regional partnerships, with waste agricultural products increasingly used for biomass energy production, and the heat from those processes reused in district heating networks for local homes, hospitals and schools.

Through this period, the electrification of the UK energy system becomes the primary mechanism by which further domestic emissions reductions are to be achieved. After years of technological development, attitudinal change, and investment in infrastructure, the groundwork has been laid for a decade of mass electrification of the transport sector. Significantly increased demand is also anticipated from the electrification of residential heat.



With the roll out of smart meter technology essentially complete, householders are better able to assess and understand the impact of particular energy related activities. Energy companies begin to roll out advanced metering contracts, with households offered incentives to allow appliances including fridges, freezers, hot water tanks and storage heaters to operate partly in response the needs of the grid. Towards the end of this period, such contracts are making a valuable contribution to load balancing.

The retrofit programme for vulnerable households begins to scale down, with the majority of intended recipients having been targetted by 2030. Retrofit work continues apace in the private sphere, as households seek to reduce their vulnerability to sustained high energy prices through improved insulation and microgeneration. Such retrofit solutions increasingly include community-wide schemes, allowing deployment of biomass power stations and district heating systems.

Earlier regulatory measures to improve the energy efficiency of household appliances have ensured that all new electrical appliances now meet stringent efficiency standards, although energy savings are partly offset by the emergence of ever more electrical and electronic gadgets in the home.



By 2020, changing attitudes towards food production and consumption have had a noticeable impact on the carbon intensity of food purchases.

The 'grow your own' culture continues to develop, with local networks and cooperatives for knowledge (and produce) exchange, and expanded allotment schemes including 'city farms' run by urban households. These schemes are successful not just in reducing food expenditure directly, but in influencing people's attitudes towards the food that they do buy, with stronger support for local and organic produce.

This adoption of more pro-environmental attitudes to food purchasing is reinforced by continuing price increases for carbon intensive products, including meat and air-freighted foods, ensuring that low carbon food consumption is widely established as a way of life.



By 2020, the charging infrastructure for plug-in hybrid/electric vehicles has reached a critical level of deployment, ensuring that these are increasingly seen as the technologies of choice for new car purchases. Although petrol/diesel engines continue to play a role, this is increasingly as a range extending device in plug-in hybrid vehicles. By the end of the decade, the purchase of new internal combustion engine vehicles is negligible, and their share of the overall vehicle fleet has fallen significantly.

Through the 2020s, investment in public transport ensures further electrification of the rail network, while the introduction of new high speed rail lines leads to increased passenger miles by train. Crucially, efforts are made to integrate all aspects of the public transport infrastructure, and to streamline payments and journey planning, encouraging further adoption of public transport among commuters.

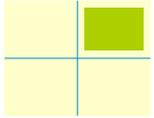
Improvements in information and communication technologies continue to impact on working arrangements, with more employers allowing and even encouraging employees to work from home where appropriate.



With the implementation of strict emissions targets for the aviation industry, costs increase considerably through this period. With improved public transport infrastructure in the UK, domestic flights begin to fall, and with high speed rail links to many parts of Europe, growth in short-haul european flights is halted.

International long-haul flights prove more difficult to curb, although with higher prices and changing attitudes on the part of holidaymakers - increasingly prepared to look for holiday destinations closer to home – growth begins to slow.

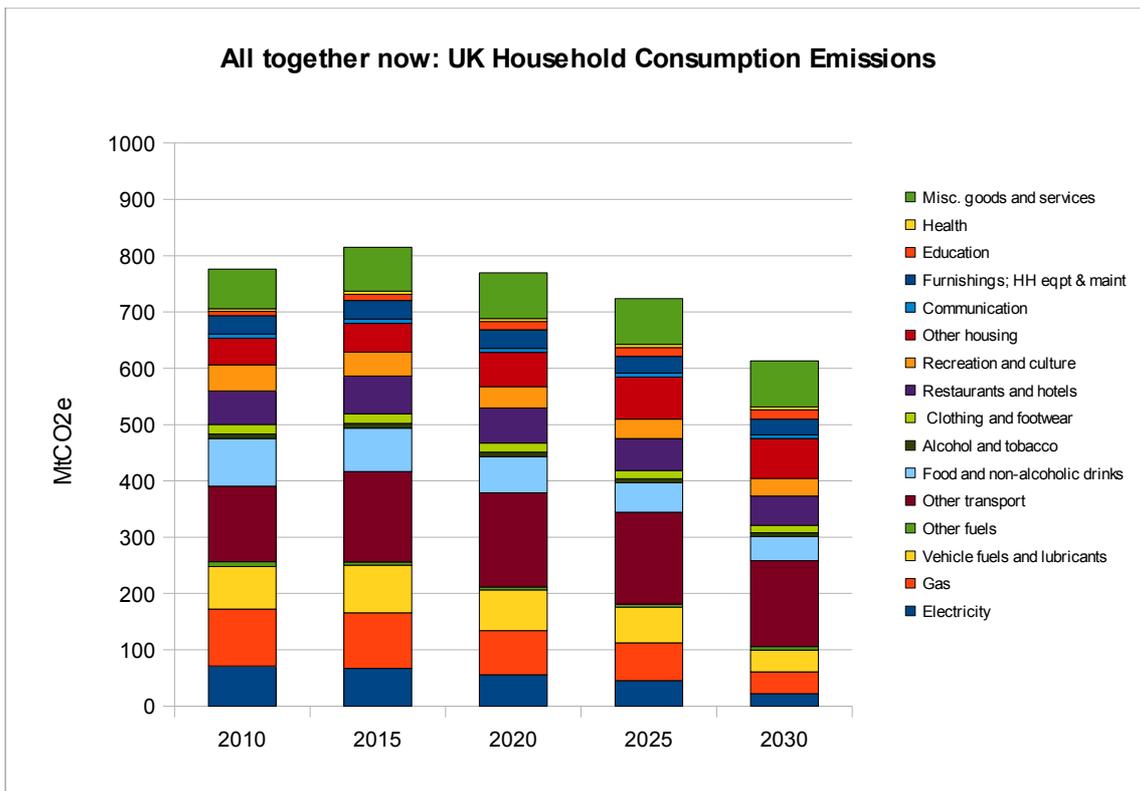
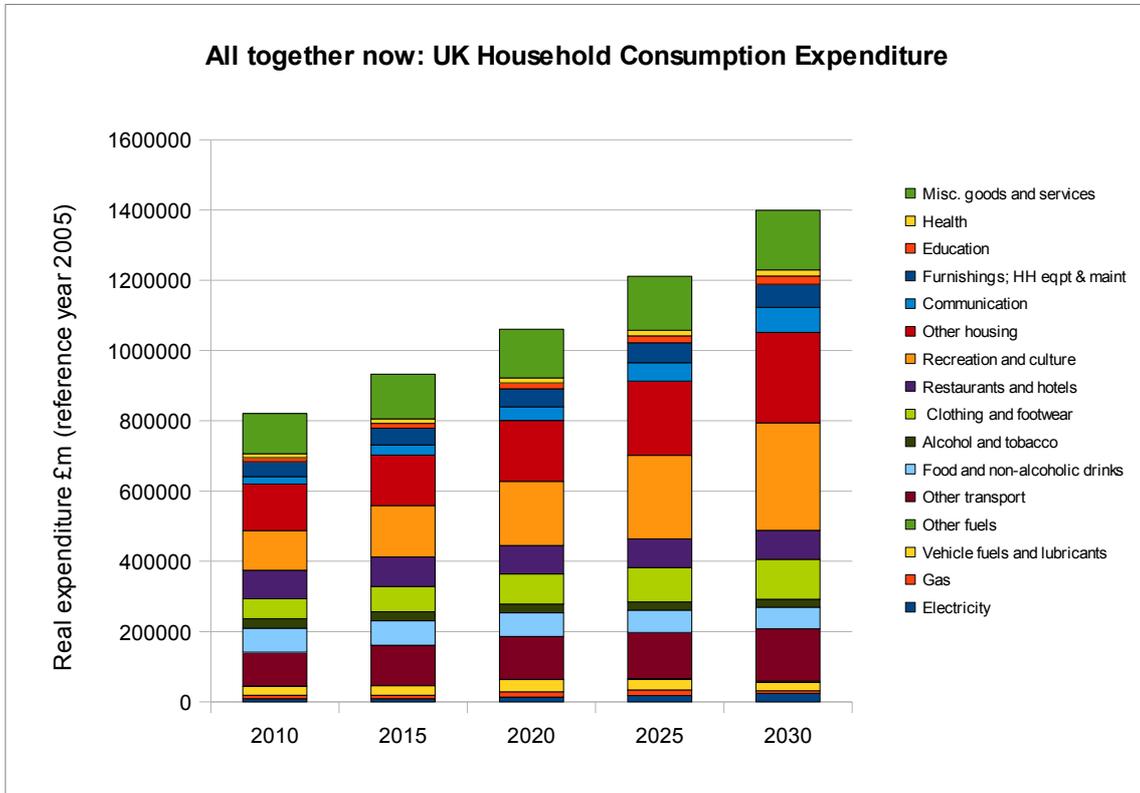
In addition to behavioural change resulting from price signals and more pro-environmental attitudes, logistical and technological developments ensure a leveling off of aviation emissions attributable to UK households by 2030.



2010

2030

Expenditure and Emissions Summary





Unilateral climate action by the EU is intended to draw further commitments from other parties, but with no such action forthcoming by 2015, the EU threatens the use of trade measures. After a period of heightened political tensions and economic slowdown, a compromise is reached. The result is a series of bilateral emissions targets that remain insufficient to avoid dangerous climate change. The UK public are cautiously optimistic at first, but without commensurate international action, enthusiasm for pro-environmental behavioural change is weakened.



In the aftermath of Copenhagen, enduring divisions between the various parties in the negotiations overshadow the efforts of sustainability advocates to rebuild a sense of momentum towards action on climate change. Instead, campaigners in the EU and US focus on green jobs programmes as a route to recovery.

The shifting political landscape in the US ensures that commitment to low carbon development remains weak, with rhetorical demands for commensurate action from China, and energy security the predominant policy objective. With the increasingly distant prospect of federal climate legislation, some individual states set out their own policies on low carbon development, including regional emissions trading schemes, green jobs programmes and industrial efficiency targets. However, these initiatives come under concerted attack from carbon-intensive industries and conservative political groups.

Continuing to insist that developed countries must lead on climate action, China refuses to commit to binding targets, but pledges that it will adhere to existing, voluntary measures on energy efficiency.

In the EU, campaigners are cautiously optimistic as leaders agree to an improved emissions reduction target of 30% on 1990 levels by 2020 in an apparent effort to encourage action from the US and China.



With hopes fading for an international agreement in the short term, UK sustainability advocates focus on securing domestic action in line with the improved EU emissions targets, including a green jobs programme to lead an economic recovery.

Afraid that such action is threatened by proposed austerity measures, the environmental lobby join trade union activists in offering fierce resistance to public spending cuts.

In the absence of any significant climate action outside of the EU, the UK media is divided over the issue, with some commentators joining the call to reign in spending cuts in support of green growth while others insist further unilateral action would be futile, and would only cede bargaining power.

Pressured by the improved target at the EU-level and increasing calls for action at home, the UK government announces an improved emissions reduction target of 42% by 2020, on 1990 levels, but signals that an increased proportion of reductions may be met through carbon trading and offsetting measures until an international agreement is reached.

Alongside the revised emissions target, the government announces it is ringfencing funding for emissions reduction initiatives and providing measures to boost green jobs.

A green bank is also established, amid concerns that it will simply streamline existing investment commitments. Although government announces some fresh funding, fears remain that - with the increased role for carbon trading and offsetting - the green bank will be used to fund projects that fail to provide 'additionality' of carbon savings.

In a bid to counter such criticism, a range of domestic programmes are some of the first to be given support through the green bank, including support for wind turbine manufacture and other renewables research and development.



Sensing that the public remain divided on the merits of unilateral climate action, government stops short of adopting policy measures that risk being seen as restrictive of lifestyles. Instead, policy is focused on the 'cost saving' arguments for action, through retrofit schemes funded by the private sector, and costs recouped from savings on household bills.

Towards the end of this period, the lack of international cooperation leave the public unwilling to adopt measures that are seen as self-sacrificial, but investment focused on green growth and opportunities to adopt more eco-friendly purchasing behaviour are broadly welcomed.



Through a combination of energy efficiency and conservation measures, investment in renewable capacity and extensive carbon trading and offsetting, the EU remains nominally on track with emissions targets by the end of this period. Environmental groups are scathing of the role of carbon offsetting, arguing that real emissions reductions fall far short of the levels required.

In the US, efforts by individual states to establish their own industry efficiency standards and emissions targets have been hampered by intensive lobbying and legal action.

In China, growth remains the priority, with no strengthening of emissions targets beyond existing efficiency goals.

In what feels like the last roll of the dice ahead of an international summit in 2015, global sustainability campaigners warn of serious economic consequences resulting from failure to secure a deal.

Unilateral action by the EU has failed to prompt a commensurate response from either the US or China. Bowing to intensified lobbying by energy and other heavy industries who face tough carbon constraints, the EU warns other parties that trade measures are being considered in order to protect those industries against cheap, carbon-intensive imports.



A national roll out of smart meters and energy display devices begins in this period, although coverage remains too low to deliver significant savings through behavioural change. Ambivalence at the household level towards voluntary actions on climate change prevents any significant attitudinal or behavioural change around household energy use.

There is an increase in the uptake of retrofit and micro-generation technologies by private households over the period, although a relatively low starting point means there is only a small impact on demand for gas and electricity.

In line with an improved emissions target, the EU establishes plans for increasingly stringent efficiency standards for electrical goods over the forthcoming decade.



Environmental groups seek to influence dietary habits through the promotion of a low carbon diet, gaining some support from celebrity chefs and supermarket chains, but with limited uptake from hesitant consumers.

Efforts to encourage home growing of basic food staples are also met with brief enthusiasm but limited success. Meanwhile, food waste is reduced to some extent.

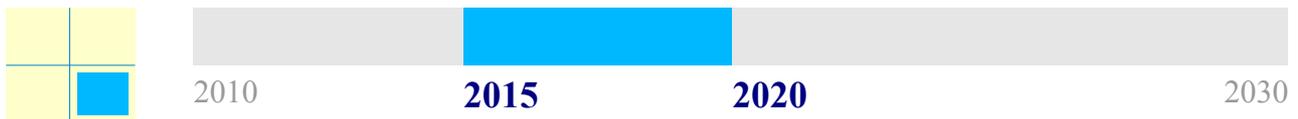


Although initially constrained by the slow recovery, sales of new vehicles begin to pick up again with more fuel efficient models enjoy an increasing share of the market. Demand for electric and hybrid vehicles also send positive signals to manufacturers regarding the promise of future sales.

Lingering scepticism around the merits of voluntary behavioural change prevent any significant shift in environmental attitudes towards transport use.



After falling during the recession, aviation bounces back with strong growth. Even with aviation brought into the EU Emissions Trading Scheme in 2012, the move has little impact on prices due to the abundance of permits allocated to the industry.



The 2015 summit descends into crisis, with seemingly intractable divisions between negotiating parties. Despite desperate efforts from a broad alliance of activists to push for an agreement, the summit fails to reach a conclusive outcome, putting the entire UNFCCC process in doubt.

The EU sets a timetable for the imposition of trade barriers to protect carbon intensive industries and prevent them from relocating to other regions, sparking immediate retaliation from the US and China through the World Trade Organisation.

The period is marked by a slowdown in economic activity as trade disputes multiply between key countries and trading blocs.

In the US, efforts to boost energy security focus on the development of North American fossil fuel supplies.

In China, increased priority is given to developing the domestic market.

Increased demand from developing nations puts upward pressure on prices, just as world markets are marred by trade disputes, leading to significantly increased prices for commodities and fuels.



In the UK, as elsewhere in the EU, business certainty is rocked by developments in international trade. Industry opinion is divided on the merits of trade action. Those that largely serve the European market argue trade barriers are necessary if their businesses are to be protected from competition from cheaper, more carbon intensive imports. Others, particularly exporting industries, raise concerns that their goods will be less able to compete on the international market if strict emissions standards are driven through domestically without commensurate action abroad.

Uncertainty around the international situation saps investor enthusiasm for industrial decarbonisation projects, although many other investment opportunities remain attractive such as renewable energy installations, with domestic government commitments unaffected by international concerns.

Funding for the green bank remains at a low level, with government nervous about redirecting further funds to low carbon development at a time when the economy is experiencing a slow down as a direct result of trade action resulting from lack of climate action abroad.



In the light of funding and political constraints, plans to roll out a nationwide retrofit of vulnerable households are shelved.

Ongoing investment in electricity decarbonisation continues to deliver carbon reductions, even as demand is rising. But if plans for the electrification of transport and heat are to proceed, far greater capacity is required than the current investment climate is delivering.

With uncertainty around how international trade disputes will be resolved, there is some reorientation of the economy around local production of goods and services. Although resulting in overall emissions savings, from reduced transportation and more efficient production processes, this relocalisation also brings those emissions back within the jurisdiction of the UK, putting further stress on self-imposed emissions targets.

Although the trade disputes have encouraged some increase in domestic production, consumers are increasingly resentful of the increased costs arising from these disputes, with consumer groups drawing attention to the impact of increased prices on the poorest in society, and calling for a rethink on the pursuit of unilateral action.



Isolated climate action in the EU has resulted in significant emissions cuts, but the use of carbon offsetting schemes to make up the gap between actual cuts and legally-binding targets has drawn sharp criticism from other countries and from critics within the EU.

International trade disputes and rising commodity and fuel prices have taken their toll on the global economy, leading to calls for international compromise on trade and emissions cuts.



The roll out of smart meters and energy display devices continues over this period, leading to widespread coverage by 2020. The devices encourage some reduction in electricity demand due to cost concerns, but with continuing reservations towards pro-environmental behaviour, significant householder engagement around energy reduction has failed to materialise.

Retrofit of private households proves increasingly popular, with demand increasing as fuel costs soar. However, plans for a publicly funded retrofit programme across vulnerable households are put on hold over this period.

Attempts at improved standards for the energy efficiency of household appliances are stalled amid trade disputes. With increasing demands in terms of the size and performance of appliances such as televisions, consoles, fridges etc, electricity use for these appliances increases.



Although the trade situation has encouraged some increase in demand for domestic food produce, this shift has taken place amid resentment rather than enthusiasm, with many consumers feeling they are being penalised by increased costs when trade measures have failed to elicit legally binding commitments from other countries. Adoption of a lower carbon diet is therefore a by-product of higher prices, rather than enduring attitudinal change.

Another by-product of increasing prices is the reduction in food waste, as households become increasingly conscious of the need for better food purchasing, planning and storage to reduce overall costs.



The research and development of electric vehicles and the necessary charging infrastructure have been a priority of EU governments, providing some investor confidence during a time of uncertainty around low carbon investments. However, with less enthusiasm for such technologies outside of Europe, and trade barriers affecting the import of key materials and components, technological development has been slower than hoped. Sales of electric vehicles have increased, although with persistently high purchasing costs the mass electrification of transport seems a more distant prospect. Plug-in hybrid vehicles have taken a larger share of the market, while the traditional internal combustion engine seems set to dominate the market for the foreseeable future, with steadily improving fuel efficiencies in response to concerns over fuel prices.

Increasing fuel prices encourage private car owners to economise to an extent, although there is little appetite for a significant shift to public transport or walking/cycling.



Although flights within the EU are subject to the Emissions Trading Scheme, the industry continues to benefit from a generous allowance of permits. Attempts to apply charges for international flights become yet another area of dispute through the WTO.

Increased fuel prices have had some impact on the growth of the industry, but enthusiasm for foreign travel is otherwise unabated.



With little progress on emissions reductions from other parties, the appetite within Europe for further unilateral action on climate change is severely diminished.

Meanwhile, there is an increasing acceptance within the US that action on climate change is both necessary and inevitable, and a softening of the Chinese stance on a legally-binding emissions cap. In an orchestrated stand down from the deadlocked trade disputes, the EU begins to scale back its use of trade measures, in return for bilateral agreements on emissions reductions from trade partners.

After years of trade disputes and the threat of increasing protectionism, the result is a compromise which - through some energy efficiency savings – stabilises commodity and fuel prices on world markets in the short term. Nevertheless, critics insist the bilateral agreements fall far short of the drastic cuts in emissions necessary to tackle climate change.

While European countries continue to pursue domestic decarbonisation programmes, the dismantling of trade barriers means consumption of carbon intensive imports continues to grow.



In the UK, the dismantling of trade barriers leads to a resurgence in economic growth in the short term, and a drop in prices of goods and services from overseas.

Though domestic emissions continue to fall as a result of ongoing decarbonisation programmes, a flood of cheap carbon intensive imports causes emissions from consumption to rise rapidly before beginning to stabilise, as producer countries begin their own decarbonisation programmes.

Through the 2020s, environmental groups push hard to raise awareness of the impact of embedded emissions. For some, the disparity between domestic and foreign carbon intensity is a reason to 'buy British', but recent experience with trade measures and the resulting price impact leads most consumers to believe that the solution is further decarbonisation of those overseas economies, rather than the relocalisation of their own. Concessions on emissions from the US and China, however limited, simply reinforce this view.

Good progress is made with electrification of transport and heat over the decade, but delayed investment during the previous period and subdued public support mean that the energy system remains significantly dependant on fossil fuel inputs by 2030.



With coverage of smart meters essentially complete, households are better able to monitor and minimise energy use as a cost saving measure. By the end of the period, more advanced metering contracts become available, enabling cheaper per unit electricity in exchange for flexible operation of appliances including fridges, freezers, hot water tanks and storage heaters.

With high prices having contributed to a significant increase in fuel poverty, a nationwide programme of retrofit for the most vulnerable households is finally given the go ahead. Despite a delayed start, increased capacity in the industry means this work can proceed rapidly, contributing to significant reductions in gas use by 2030. Retrofit of private households continues apace.



The immediate drop in food prices after trade barriers are removed leads to a significant increase in imported, particularly air-freighted food products. The prospect of emissions reductions from producer nations, however limited, ensures a low level of consumer engagement around the carbon intensity of food purchasing.

The return of lower food prices also means a slight relapse in levels of food waste.



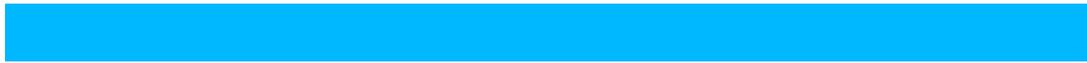
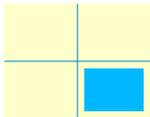
Further investment in infrastructure and technological development through this period makes electric and plug-in hybrid vehicles increasingly financially viable. By the end of the period, these account for the majority of new vehicle sales, although internal combustion engines continue to dominate the existing vehicle fleet.

As well as a preference for fuel efficiency in the purchase of new vehicles, increasing vehicle fuel costs lead to a reduction in single person car journeys, with colleagues, neighbours and friends finding ways to combine journeys where convenient, aided by advances in information and communications technology.

Increasing vehicle fuel costs also lead to an increase in public transport use, with electrification of the rail network leading to further emissions reductions.



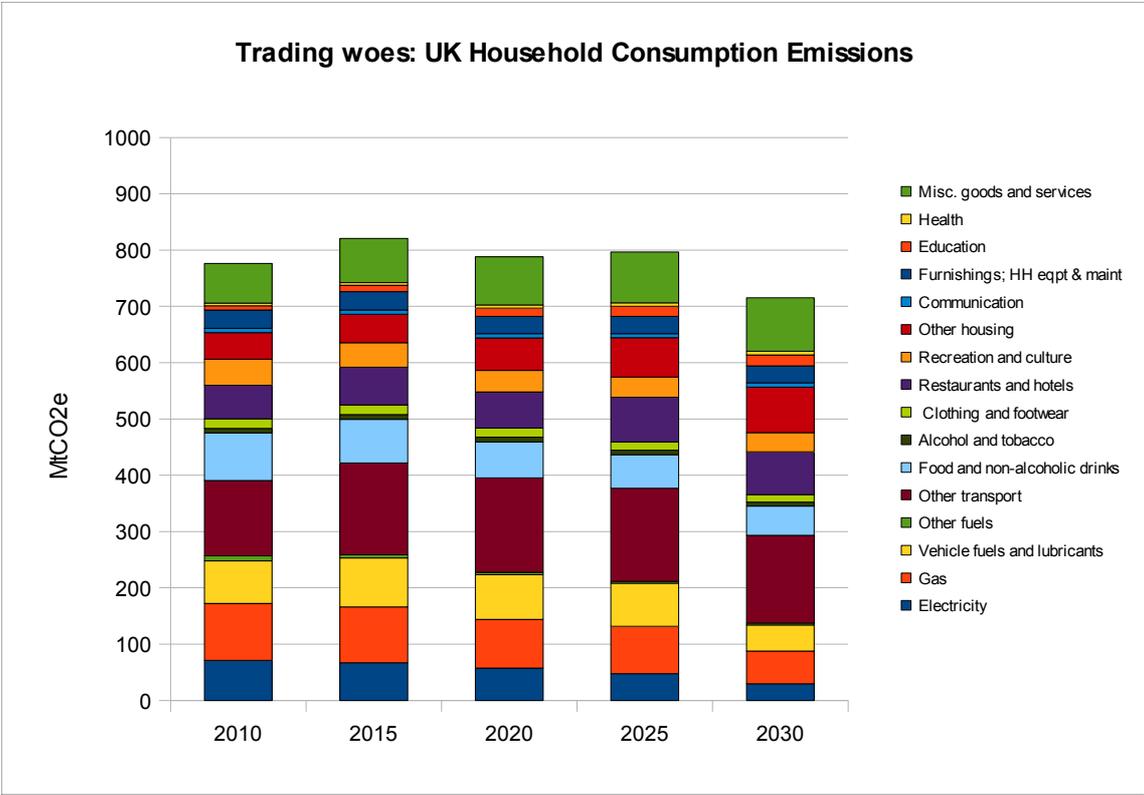
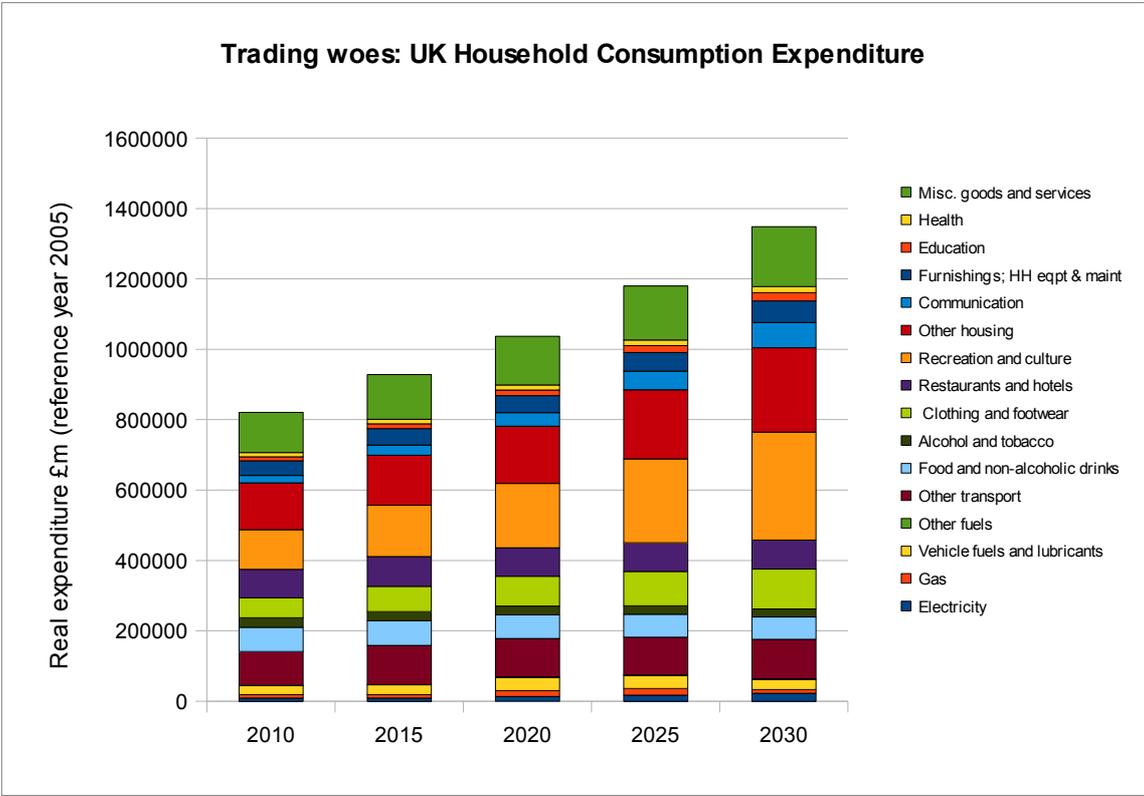
With aviation now receiving fewer allowances under the EU ETS, costs begin to increase over the period. Concessions on tackling international aviation mean that long-haul flights gradually become subject to carbon pricing, but the appetite for foreign travel ensures continued growth in aviation emissions attributable to UK households.



2010

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Expenditure and Emissions Summary





With little effort on emissions reduction, the global economy is exposed to increasing fuel prices towards 2020. With intensified social pressure to reduce fuel prices, and unable to work cooperatively on establishing an equitable emissions regime, countries instead pursue divergent, often conflicting energy security policies. The persistence of fossil fuel extraction as part of those policies extinguishes any hope of a low carbon transition, and leads to international conflict.



The failure of Copenhagen leads to a loss of faith in the UNFCCC process and the effective abandonment of any serious attempts to secure an international emissions regime.

Short term action is taken around the world to stimulate the global economy.

Commodity and fuel prices remain below pre-recession levels for some years, offering little incentive for energy or resource efficiency.

Media portrayal of climate science and activists is increasingly scathing, with the individuals involved being accused of pushing a political agenda that risks undermining the recovery. Extreme weather events are attributed to natural variability and in many cases to poor development strategies, including deforestation.



Prioritising deficit reduction, the UK government renege on a number of key environmental policies, focusing political capital on pushing through cuts in public spending.

Amid the austerity measures, employment remains the primary concern for the majority of households.

Climate scepticism among the public is fed by further negative portrayals of climate science in the popular UK media, even as limited corners of the progressive UK media report on climate change in accordance with the mainstream scientific findings.

The environmental movement fails to attract significant support over the period with enduring scepticism on the part of the public preventing any significant behavioural change or political action.



A lack of funding mechanisms prevents any significant expenditure on home insulation, let alone micro-generation.



With food prices remaining relatively stable, and in the absence of any other behavioural incentives, food consumption patterns show little change over this period.



The slow recovery limits new vehicle sales at first, and when sales do begin to pick up there is no significant 'above trend' shift to more fuel efficient models. Lack of any behavioural incentives over this period means no significant reduction in vehicle use, e.g through a shift to public transport use or car sharing.



As the economy recovers, and in the absence of any policy measures to mitigate against aviation growth, the industry sees record passenger numbers.



From 2015, rising global demand leads to significant increases in prices of commodities and fuels.

The global environmental lobby calls for a transition away from fossil fuels, but these calls are drowned out by lobbyists in different countries insisting on further investment in fossil fuel resources for energy security.

In the US, this leads to rapidly increased investment in non-conventional oil and gas and further deep sea exploration. In Europe, there are calls for closer cooperation with Russia to secure long term gas supplies, and investment in deep sea oil and gas resources in the Arctic and North sea.

By 2020, significantly increased investment helps to stunt the increase in fuel prices but with little action on developing alternative energy solutions, countries remain locked in to carbon intensive development for the foreseeable future.



In the UK, increasing fuel prices lead to some reduced consumption but social pressures on government to act eventually lead to some reduction in fuel taxes. Towards the end of this period, significant investment in oil and gas exploration reduce these price pressures, removing any real incentive for households to adopt significant energy conservation measures.

Meanwhile, some decarbonisation of the electricity supply has taken place, through increased investments in renewables and further switch from coal to gas. However, the absence of sufficient direct support in the form of subsidies, and the lack of any real prospect of a global emissions regime lead to a slow down in investment in renewable capacity.



Despite temporary price increases during the early part of this period, the slowing of this trend offers little incentive to households to invest in retrofit measures. Insufficient support for micro-generation also prevents any significant adoption of these technologies.



Food prices are affected by increased global demand and higher fuel prices. Consumers respond by shifting to more affordable food products with little impact in terms of reducing carbon emissions.

In addition to purchasing cheaper food products, some action is taken to reduce food waste in response to high costs.



A significant rise in vehicle fuel prices is then alleviated through reduced fuel tax, removing pressure on households to shift from private car use, or towards more efficient vehicles. Although the research and development of electric and hybrid vehicles continues, insufficient funding ensures these remain expensive and very much on the periphery.

With environmental attitudes undergoing little change over this period, and vehicle fuel prices brought under control, there is little appetite for a shift to public transport use, or walking/cycling as an alternative.



Aviation fuel costs rise over this period, then stabilise. Meanwhile, increasing household disposable income means that even in the face of increased costs, this important aspiration is increasingly fulfilled.



In Europe and the US, measures to bring additional fossil fuel supplies onstream have helped to alleviate price pressures in the short term. While gas supplies remain sufficient to meet demand over this period, oil supplies plateau through to 2025.

In the first half of this period, in developing countries, increased prices for food, fuel and basic commodities leads to social unrest and humanitarian crises. In developed countries, despite measures to increase domestic oil production, limited global supply leads again to steadily increasing prices.

The global market for oil becomes increasingly redundant as powerful consumer nations pursue direct bilateral supply agreements with producers.



In the UK, some increased renewable capacity contributes to the electricity supply, but apparent lack of public support for a wholesale decarbonisation programme have seen increased gas supplies used to replace retiring coal and nuclear power stations.

With domestic oil supplies grossly inadequate to meet demand, and global market mechanisms under threat, the UK looks vulnerable to oil shocks. With increasing prices once more towards the middle of this period, pressure mounts on government for further tax reductions.

While environmental campaigners continue to call for desperate measures to shift away from fossil fuels, the movement becomes increasingly marginalised from the crisis politics that defines the period. Rising membership of environmental NGOs among young people offers hope, but can do little to divert the UK from its current path in the short term.



Towards the end of this period, it is established that global oil production peaked in 2025. The associated price shocks lead to economic crisis. Major oil consumers, including the US, Europe and China compete for access to remaining oil resources, particularly in the Middle East, leading to military skirmishes and conflict by proxy.

Meanwhile, efforts to increase production of unconventional oil supplies receive substantial investment, enjoying a level of commitment that sustainability advocates could only have dreamed of with regard to their own cause.

Competition over oil leaves many developing countries unable to secure the feedstocks for agricultural production, leading to widespread humanitarian disaster.

Transportation costs also affect global trade, with air freight becoming increasingly untenable.



In the UK, an oil price shock pushes the economy into recession towards the end of the period.

Despite right wing calls for intervention abroad, the UK's reduced standing in the world leaves little scope for competing with the US and China for oil resources. Instead, emergency measures are introduced to ration fuel for agricultural use first, public transport second, and private car use last.



Significant steps to secure long term gas supplies has removed any immediate pressure on households to adopt retrofit measures to reduce gas consumption, although prices rise again towards the end of this period, tracking high oil prices.

Household electricity demand continues to increase over the period, but insufficient investment in renewables and continued reliance on gas means reduction in emissions proceeds slowly.



In the early half of this period food consumption is impacted by increasing prices, but this is partially offset by increasing incomes and continued adaptation through purchase of cheaper food products. As the period progresses, a crisis in global food production leads to shortages of imported foods. As a result, households are forced to adopt dietary changes that imply some reduction in carbon intensity.

Food waste is significantly reduced over this period, as pressures mount on households for better management of household budgets.



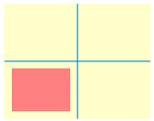
Despite a stabilisation of prices for vehicle fuels by the beginning of this period, global developments lead to further price shocks, partly offset by government action to reduce fuel taxes. By the end of the period though, private car use has been significantly curtailed.

Where private cars are used, measures are in place to effectively oblige drivers to carry passengers. Fuel inefficient vehicles are subject to increasing vilification. More efficient vehicles take up a far larger share of new vehicle sales, although sales drop away to due to the recession. Electric and hybrid cars see a surge in popularity, but from such a small base that they make up only a small share of the market by 2030.

Public transport use sees a surge over the second half of this period.



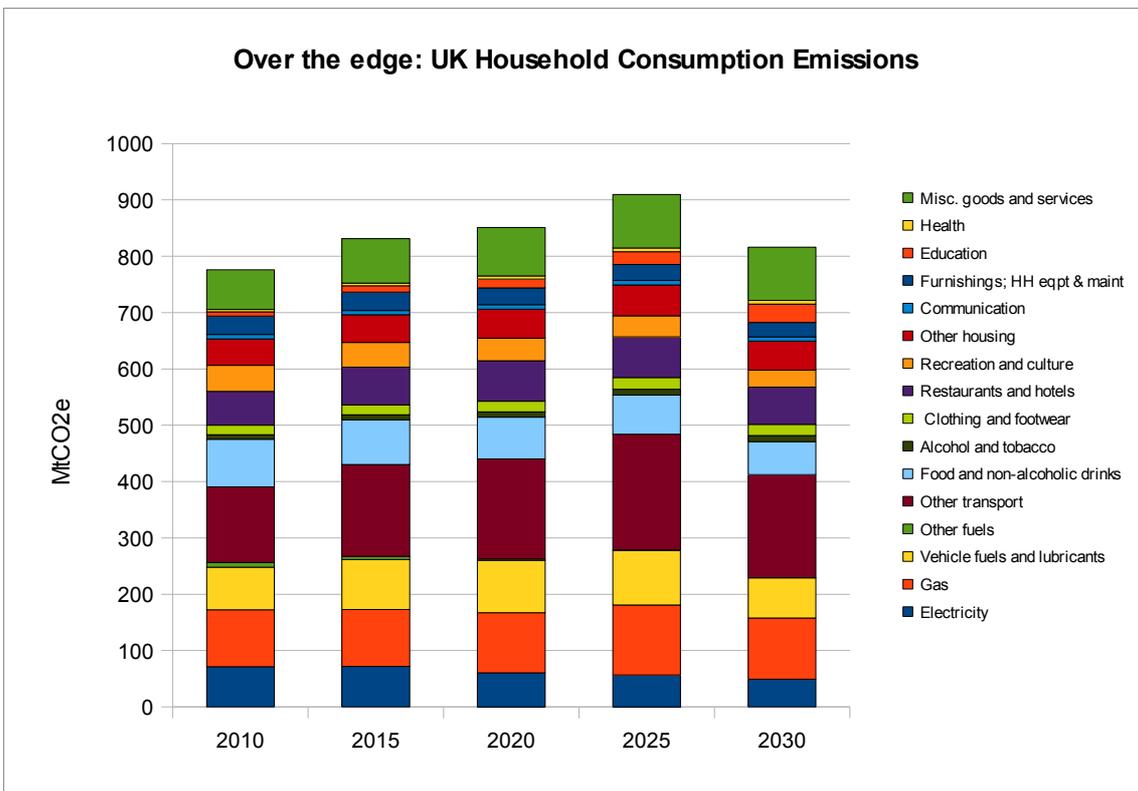
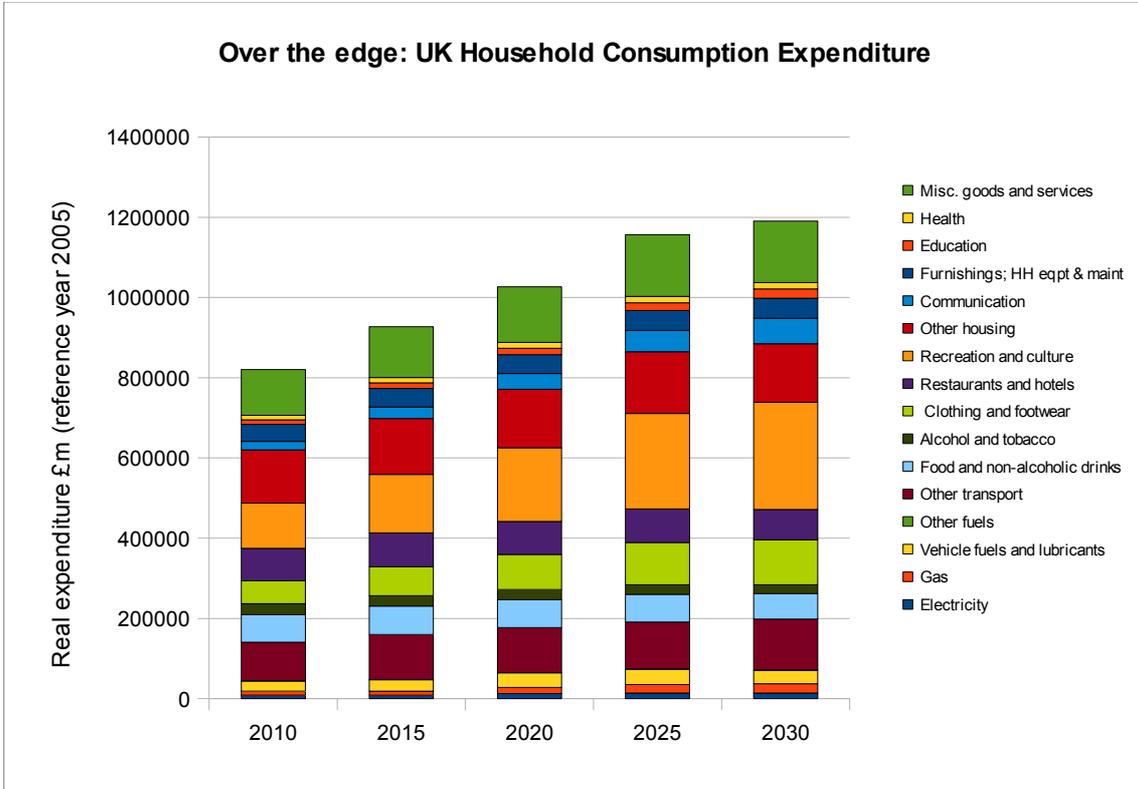
Gradually increasing prices in the early half of this period give way to wholesale shocks, with many airlines falling victim to economic conditions. In the UK, a combination of the high cost of aviation fuels and an economic recession leads to a collapse in demand towards the end of the period.



2010

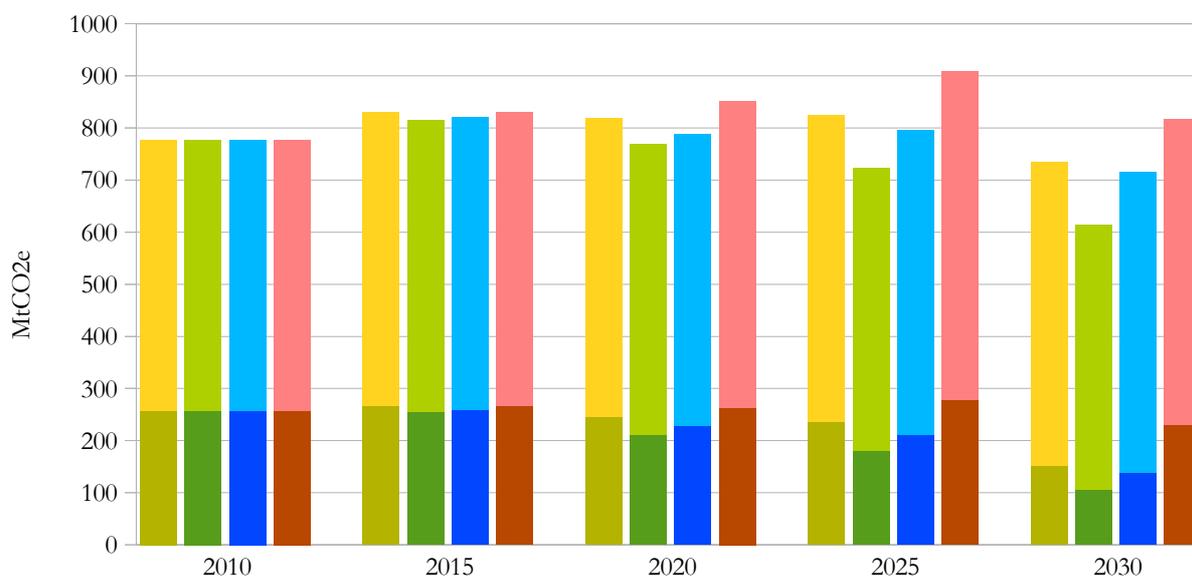
2030

Expenditure and Emissions Summary



Emissions comparison

In the preceding sections, each of the four scenario narratives were accompanied by two graphs summarising total expenditure and emissions (across all categories of goods and services) associated with UK household consumption from 2010-2030. More specific details about the assumptions used for each variable in each category and across each time period are available in the supplementary data, along with a series of notes explaining the reasoning behind those assumptions. A comparison of the total *expenditure* charts reveals a relatively consistent set of pathways across the four scenarios, with the exception of 'Over the edge', in which economic turbulence from 2025 onwards results in stagnating household incomes and expenditure. More pronounced is the difference in *emissions* trajectories between the four scenarios, compared below.



UK household consumption emissions (in MtCO₂e) across the four scenarios (from left to right): **Better late than never**, **All together now**, **Trading woes**, **Over the edge**. The darker shaded section of each column indicates direct emissions, while the lighter section indicates embedded emissions

Looking at these four emissions trajectories, a number of observations can be made with regards to the general direction of each. In **All together now**, emissions continue to increase in the first five years, but decline steadily thereafter, to end at the lowest level of all the four scenarios. **Over the edge** demonstrates a steady increase in emissions through to 2025, before events described in the narrative lead to a severe economic contraction resulting in significant emissions reduction. Despite this drop towards the end, the fossil fuel intensive nature of economic development here means that emissions remain at the highest level of all four scenarios. In **Better late than never**, rising price of fossil fuels and commodities slows the economy towards 2020, before a strong global commitment to decarbonisation leads eventually to a decline in emissions. In **Trading woes**, there is a proactive attempt at decarbonisation across Europe in the first half of the scenario, but trade conflicts with China and the US have their own dampening effect on the economy, and the resulting compromise adversely affects the rate of emissions reductions. Thus, despite their distinct development pathways as described in the narratives, the net result is a close proximity in the 2030 emissions levels between **Better late than never** and **Trading woes**.

Recent developments

In the construction of any set of scenarios, it seems inevitable that the key themes, uncertainties, drivers and outcomes of interest will - to a significant extent - be a product of their time and place. The wider social and cultural setting of the work and of the facilitator(s), experts and participants will necessarily influence the process, and the emergence in the recent past of particular threats and opportunities in the public discourse will influence the perceived significance of different variables. There is therefore an inescapable subjectivity about the framing of the 'problem' space and the articulation of 'solutions' to that problem.

It is also inevitable that significant events will come to pass *during* the course of constructing the scenarios, challenging and/or vindicating the selection of particular variables and parameters in different ways. The present study has certainly witnessed important developments, both stresses and shocks, that might impact on the perceived significance of different variables included in the scenarios, and the direction in which those were assumed to unfold in the given circumstances of each narrative. Although there have been many developments over that time, it is perhaps worth reflecting on those that relate most strongly to the two key uncertainties and to the challenge of high oil and food prices, starting with the latter.

Food and fuel prices

Earlier it was explained that a period of rising costs of fuels and basic commodities would be introduced to each scenario, from 2015-2020. The particular conditions of each narrative would then determine the social, political and economic implications over the subsequent period. The decision to include such a development was motivated by the increasing prominence of concerns over oil depletion, including a report by the UK Energy Research Centre (UKERC) which pointed to a significant risk of a peak in conventional oil production before 2020.

Oil prices had reach \$147/barrel in 2008, with a knock on effect on food and other commodity prices. However, the financial crisis that followed (and the subsequent drop in global demand for oil and commodities), coupled with the apparent slow recovery, were taken as a reason for assuming that any future oil price rises would be some time in coming. In fact, over the course of the development of these scenarios, oil prices have recovered from a low of around \$35/barrel in 2009 to over \$115 in March 2011. At the same time, global food prices have reached historic highs.

A comprehensive analysis of the causes and effects of these price changes is beyond the scope of this discussion, but at the time of writing it is clear that there are pressures on both supply and demand, including: unrest in the MENA (Middle East and North Africa) oil producing countries; growing demand from emerging markets; increased domestic consumption within oil producing nations, increased costs associated with extraction of non-conventional oil (not forgetting the cost of disaster response as in the case of the BP Deepwater Horizon tragedy).

An analysis of factors behind the record food prices is also beyond the scope of this study, but once again these clearly include a mixture of demand and supply side pressures, such as: the changing diet of the burgeoning middle class in developing countries and the impact of numerous extreme weather events on food crops in 2010.

Important to note here is the dynamic interplay between these different factors, with higher oil and gas prices leading to higher costs of energy and resource inputs for agriculture, and higher food prices contributing to the unrest in MENA countries and the subsequent impact on oil production.

It was suggested in the scenario narratives that developments in energy and environmental policy, as well as social outlook, would determine how well-equipped the world would be to deal with these crises through 2015-2020. With price pressures reappearing so soon, however, the exact role of social and political factors in responding to these remains in the balance. Much depends on whether these price levels stabilise, fall away, or even intensify in light of further developments. Clearly, the global (and UK) economy can only withstand so much, but exactly what level oil prices would need to reach and for how long, to bring about a recession, remains a point of ongoing debate. At the same time, the higher fuel prices might be the catalyst for a rapid shift in social and political attitudes towards a low carbon transition. In developing countries of course, the impact of high food prices is felt all the more severely, and the spectre of humanitarian crises abroad - as articulated in some of the scenarios - could well play a part in motivating abrupt social responses in the UK, sooner than imagined.

Europe

One of the key uncertainties used to frame this scenario study was whether the UK (as part of the EU) would voluntarily adopt more ambitious targets at the outset of this decade, and partake in an 'early transition' to a low carbon economy.

The initial impact of the 2008 financial crisis and the perceived significance of various economic factors were clearly formative to this study. However, the crisis was far from over, nor were the full consequences yet clear, while the scenario study was being conducted. As such, a variety of economic factors related to that crisis remain deeply uncertain, affecting the prospects for a low carbon transition. In Europe, concerns over levels of sovereign debt, the so called Eurozone crisis, culminated in May 2010 with a bailout package for Greece, and fears that the crisis might spread to other peripheral Eurozone countries. In November 2010, Ireland became the second country to receive a financial package from the EU/IMF. The downgrading of some European countries by credit ratings agency continues to have an impact on market confidence well into 2011. Depending on one's political and economic outlook, concerns over levels of sovereign debt are either alleviated or compounded by austerity measures at the national level. For some, the measures are necessary to drive down deficits as quickly as possible and restore confidence, while for others the measures risk exacerbating economic woes by adding to unemployment and heightening the chances of a double dip recession.

It is impossible to know how the uncertainties around the broad economic fortunes of European countries will play out, but it should be clear that the outcomes will be crucial in determining approaches to - and levels of - investment for a low carbon economy. If anything then, the increased stakes around European countries' finances and the associated impact on energy and environmental policy have come into even sharper relief since the outset of the study.

Aside from the issue of finance, there remains the question of whether or not EU decision-makers adopt the stronger target of a 30% reduction on 1990 levels by 2020. The UK climate change secretary, Chris Huhne, has argued that a 30% target would help the EU lead the new green industries, as well as insulating the region from oil price shocks. Meanwhile, opponents of such a move have argued that the unilateral adoption of stronger targets would simply lead to further offshoring of industry. The recently announced low carbon 'roadmap' for the EU appears to suggest a compromise of 25%, although this target would require to be ratified.

International emissions regime

Ahead of the Copenhagen summit in December 2009, there was a sense of anticipation over the possibility of a comprehensive global deal, as evidenced by the responses gathered during the internal

interviews in this study. Unfortunately, by early 2010, this anticipation had been replaced by a deep sense of pessimism, even cynicism, made clear by the responses from the external interviews conducted during that period. This pessimism inevitably informed the development of the scenarios, ensuring that even in the most 'optimistic' or 'green' scenario (All together now) the emergence of a comprehensive global deal on emissions would have to wait until 2015.

The subsequent summit in Cancun in December 2010 was widely expected to achieve not very much at all, and indeed, despite talk of consensus, no further legally binding commitments were adopted over existing measures by member states. In fact, given the expectation in some quarters that the entire UNFCCC process was now defunct, even the achievement of a political agreement (to agree further measures in the future) was hailed a success. The speed of change in outlook that has taken place from pre-Copenhagen to post-Cancun - anticipation, disappointment, disillusionment, renewed hope - is a reminder of both the significance and uncertainty that continues to surround the establishment of an international emissions regime.

Reflections

Modelling of emissions and trade flows

In the introduction to this report, historical trends for three different categories of consumption emissions were explored, namely: direct, UK embedded and imported embedded emissions. A simple extrapolation was performed to highlight the dominance of imported embedded emissions under a business-as-usual scenario, suggesting the need for a UK emissions strategy that explicitly recognises and mitigates against the risk of further offshoring of emissions.

This kind of regional disaggregation of embedded emissions was not a feature of the structural time series model used for the quantification of the RESOLVE scenarios, hence the emissions trajectories provided above distinguish only between direct and embedded emissions. Nevertheless, the qualitative narratives are suggestive of certain developments with respect to the economic geography of the four scenarios, most notably in the case of **Trading woes** where trade measures lead to a period of localisation, before being dismantled to allow an influx of imported embedded emissions.

Clearly, it would be of value to policy and decision makers to see these international emissions flows modelled more explicitly, albeit subject to a range of assumptions regarding emissions intensity of production for different sectors in different regions. At the very least, for UK policy makers, a model that could disaggregate emissions from the UK, Europe and the rest of the world would be invaluable in assessing the possible impact of trade measures at the EU level to protect against carbon leakage associated with unilateral action towards a low carbon transition.

An extended model of emissions flows could also make it possible for policy makers to assess the impact of changes in UK production emissions on UK consumption emissions. The production perspective will continue to drive the analysis and advice provided to UK policy makers, including sectoral targets provided by the Committee on Climate Change (CCC) as part of its climate budget recommendations. An extended model would offer the ability to analyse the impact of these recommendations on consumption emissions, under an appropriate range of assumptions regarding trade and global developments.

Rebound effect and savings

In the RESOLVE scenario narratives, there are numerous cases where a storyline implies changes in the consumption of certain goods and services that lead to further changes in another type of consumption, e.g. retrofit of homes leading to reduced gas use. In the quantification of these storylines, this effect was modelled by increasing expenditure on the former category, e.g. household maintenance, and decreasing expenditure on the latter, e.g. gas.

The knock on effect of reduced gas use though, is avoided expenditure over time. This expenditure must either be spent on other goods and services or invested by those households. When a reduction in consumption in one area leads to increased consumption in another, the associated impact with regards to emissions is known as the rebound effect. The size of this rebound effect will depend on the consumption avoided and the new consumption undertaken. For example, reducing carbon intensive expenditure such as gas use and spending the money instead on a much less intensive category such as clothing and footwear would result in a low rebound effect, as only a small proportion of the avoided emissions would be reintroduced. On the other hand, avoiding an expensive meal out in a restaurant in favour of a full tank of petrol and a weekend drive in the countryside would lead to a much higher rebound effect. In some cases, the rebound may be so extensive as to backfire altogether, resulting in higher emissions than before.

In the quantification of the scenarios, expenditure that is avoided as a result of a particular storyline is then reallocated to other categories. This reallocation can either be distributed across remaining categories or, in the case of a storyline associated with pro-environmental behaviour change, can be assigned to specifically less intensive categories. For a more in-depth treatment of the rebound effect in terms of the consumption categories explored in this model, see Druckman *et al.* (2010)⁴.

It might be assumed that the rebound effect could be avoided if, rather than re-spending, households were to save any avoided expenditure. In fact, the investment activity associated with the use of household savings deposited in e.g. banks and building societies, have emissions impacts of their own. Since the (aggregate) carbon intensity of household investments is lower than for, say, gas use or vehicle fuels, curbing those activities and investing the avoided expenditure will of course lead to some reduction in emissions, but nevertheless subject to a rebound effect.

Although the possible role of a green bank was explored in the scenario narratives, the focus in this research on household consumption has meant that emissions associated with household investment, or savings, have not been explored quantitatively. Again, for an explicit treatment of the rebound effect resulting from various levels of re-spending vs investment, see Druckman *et al.* (2010).

The varying economic pathways of the four scenarios explored here might be expected to impact on how households choose to allocate their income between consumption or investment. Even so, knowing the level of investment is to say nothing of *how* that money is invested, and whether different investment strategies by households might lead a lower rebound effect. Clearly, a portfolio built around 'green' investments will have a different carbon intensity from one focused on oil companies.

4 see Druckman *et al.* (2010) "An investigation into the rebound and backfire effects from abatement actions by UK households", RESOLVE Working Paper 05-10

Afterword

by Tim Jackson

In 2006, Tony Blair declared that 'making the shift to a more sustainable lifestyle is one of the most important challenges for the 21st century'. It was the start of something that elevated the idea of living sustainably to the status of holy grail in the policymaking mind. In the same year the University of Surrey started a five-year research programme on lifestyles, values and environment (RESOLVE). What has emerged from RESOLVE research over that period is more about tension and conflict than it is about clear-cut solutions to the ecological and social challenges of 21st Century living. It has become clear that there are no silver bullets here, no magic carpets. No easy rides down the path of energy and carbon descent.

What we've found instead – and this is reflected in Scott Milne's crucial work on low carbon scenarios – has to do with complexity, with diversity, with the limited tractability of radical change. This complexity is typified by the carbon dependencies associated with a multiplicity of functional needs: food, clothing, shelter, health, education, communication, recreation and leisure. RESOLVE work shows how the impacts of consumption are increasingly embedded along complex supply chains that stretch for thousands of miles, defying economic, cultural or ecological boundaries. We've shown how changes in these patterns depend on complex interactions, governed as much by non-economic factors as by price and income. We've charted a myriad social, psychological and economic processes which lead, despite our best intentions, to an escalation, an acceleration of material demand and environmental impact.

We've modelled economic rebound, the process through which even our best achievements at energy restraint or carbon reduction are offset because the money we save from good practice ends up generating carbon emissions elsewhere. We've mapped the continuing battle between efficiency on the one hand, our own clever technological advances, and scale on the other - the relentless expansion of material demands. Scale outweighs efficiency at every turn.

We've paid a particularly close attention to sites of intentional change - individuals, households and communities with declared intentions to use less energy, to emit less carbon, to eat more sustainably, to invest more ethically, to live more frugally, to lead less materialistic lives. The most striking finding from these individuals and communities is not a rose-tinted vision of alternative prosperity immediately transferable from the margin to the mainstream, but a set of enduring conflicts and tensions.

How do these tensions arise and where do they come from? In the most concrete terms they come directly from physical structures. From infrastructures of energy, of transport, of food provision (for example) that are inimical to sustainable practice. To give up your car in a society built around roads is to become a second or third class citizen. However, it isn't just physical infrastructures which militate against sustainable living. It's institutional and social structures too. It's price signals and performance indicators. It's the ease of borrowing and the paucity of saving. It's the planning and execution of psychological and economic obsolescence. It's the pressure of the media and the structure of finance. Perhaps most deep rooted of all amongst these structures is our prevailing notion of social progress, characterised by the idea of ever-increasing incomes and expanding material aspirations.

Against this complex and perplexing background, we've seen very clearly how concepts of governance are stretched by the demands of sustainability, from the regulation of markets, to the stimulation of technologies, to the setting of incentives, to the internalisation of external costs, to the changing of behaviours and practices in business and households.

The technological appeal is a truly tempting one, for all sorts of reasons. Not the least of these is that new technologies are clearly needed. Renewable energy technologies, low carbon technologies, resource productivities, energy efficient appliances. All of these will be essential to achieve our carbon goals. But they will not in themselves be enough. Interestingly, it's not even possible to implement these technologies at the scale required without profound changes in behaviours and practices. Even the relatively straightforward transformation of the building stock envisaged by the UK Government's proposed Green Deal on energy efficiency requires changes, as yet ill-defined in legislation or in policy, in the behaviours of entrepreneurs, of retailers, of households, of investors and financiers.

The dominant policy framework for behaviour change focuses on individuals, and is characterised by the terminology of 'nudge'. Through subtle shifts in the architecture of choice, people will miraculously become better citizens. But the evidence shows that such incremental change at the level of the consumer is not going to be enough: a low-carbon sustainable economy and society will emerge only through real structural change that can deal with the challenges outlined above – and also with prevailing inequalities of power, of access, of income and of knowledge.

At the same time, I'm convinced that RESOLVE's fertile evidence base contains real seeds of hope. We've identified deep environmental and social values in the unlikeliest places. We've uncovered countless examples of social innovation, the circulation and re-invention of new ideas, grassroots revolutions in growing and providing food, in the transformation of local energy systems, in the provision of community finance, in the organisation of social and community-based enterprise. We've seen that there are narratives of meaning and identity that offer real alternatives to the consumer culture - consolations that consumerism simply cannot offer, and some tantalising suggestions that less materialistic lives might also be more meaningful.

None of us can be under any illusion that these findings are sufficient on their own to make living sustainably an immediate reality. But these seeds of hope, these visions of change, these practical manifestations of more sustainable lives make the long view a brighter, more colourful, more promising prospect than we might otherwise come to expect. In shaping these hopes and aspirations for the long run, and devising effective policies for change, we need rich scenarios about the changes and choices in store. Scott Milne's comprehensive scenario analysis is a vital contribution not only to the RESOLVE research base but to wider political and cultural debate on sustainable futures.

Acknowledgements

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EXTERNAL

Nick Eyre

Jackson Senior Research Fellow at the Environmental Change Institute, University of Oxford, Co-director of the UK Energy Research Centre

Chris Foster

EuGeos Limited, Visiting Research Fellow at Manchester Business School

Nicholas Howarth

School of Geography and the Environment, University of Oxford

David Kempton

Non-Executive Director of Impax Funds Ireland plc, Chairman of EGS Energy, Engineered Geothermal Systems

Matt Leach

Professor of Energy & Environmental Systems, Centre for Environmental Strategy, University of Surrey

Ruairi O'Connell

Advisor to the Special Representative for Climate Change, Foreign and Commonwealth Office, HM Government

Nick Robins

Head of Climate Change Centre of Excellence, HSBC

Francesco Sindico

(now) Lecturer in International Law, Centre for Energy, Petroleum and Mineral Law and Policy, University of Dundee