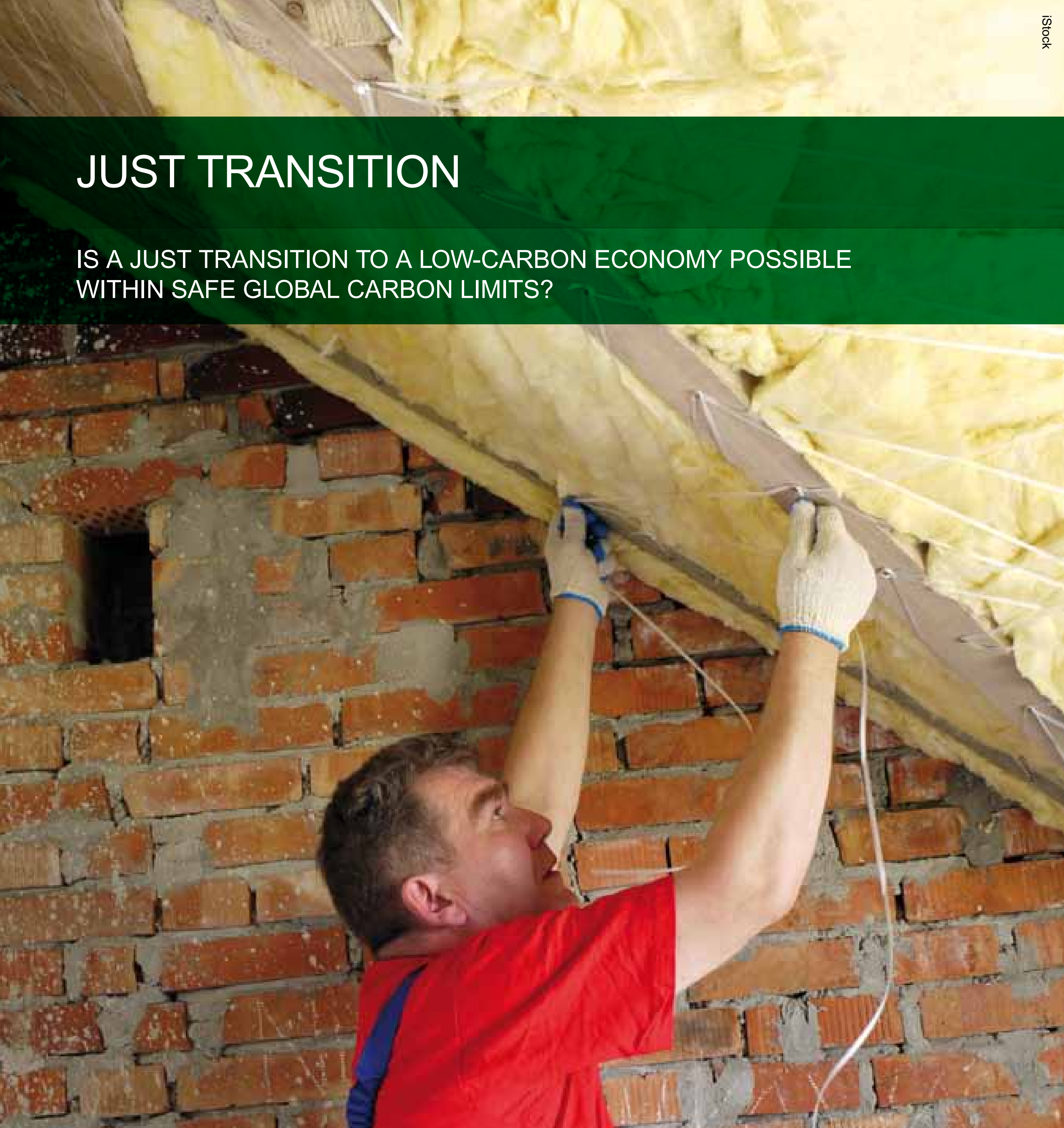


iStock

JUST TRANSITION

IS A JUST TRANSITION TO A LOW-CARBON ECONOMY POSSIBLE WITHIN SAFE GLOBAL CARBON LIMITS?

A REPORT BY FRIENDS OF THE EARTH ENGLAND, WALES & NORTHERN IRELAND

Friends of the Earth

The second of a series of three reports funded by the Anthony Rae Foundation, Zennstrom Philanthropies and Joseph Rowntree Foundation

~ANTHONY RAE FOUNDATION~

ABOUT THIS REPORT

This research addresses the question "Is a just transition to a low-carbon economy possible within safe global carbon limits?" This report identifies the substantial changes that are necessary in all sectors for the UK to live within its share of a global carbon budget that is consistent with a 70 per cent chance of avoiding global average temperature increases of 2°C above pre-industrial levels. The UK's share of this budget is identified as 9 gigatonnes of CO_2 equivalent ($GtCO_2e$) between 2010 and 2049. The research identifies policy options for achieving these changes and considers whether these can be made without a disproportionate impact on low-income communities.

Acknowledgements

We would like to thank the Joseph Rowntree Foundation for their financial support to enable this research to be undertaken. It builds upon work previously funded by the Anthony Rae Foundation. We are grateful to them. The report represents the views of Friends of the Earth not the funders.

We would like to thank the following for providing comments during the production of this research: Kevin Anderson (Tyndall Centre for Climate Change Research at the University of Manchester), Alice Bows (Sustainable Consumption Institute, University of Manchester), Stephen Tindale (Climate Answers), Robin Hickman (Halcrow), Tim Jenkins (New Economics Foundation), Leonie Green (Renewable Energy Association), Sara Fuller (Department of Geography, University of Durham), David Weatherall (Energy Savings Trust), Josh Stott (Joseph Rowntree Foundation), Anthony Rae (Anthony Rae Foundation) and policy staff within Friends of the Earth. We would also like to thank Frank Pennycook for the modelling work. The views expressed in the report are those of Friends of the Earth and any errors are the responsibility of the author.

Author

Mike Childs
Head of Science, Policy and Research, Friends of the Earth

CONTENTS

EXECUTIVE SUMMARY

Reducing the probability of dangerous climate change is a huge challenge for governments. Doing so in a socially just way creates additional challenges. This research aims to assess whether it is theoretically possible for the UK to make a just transition to living within its share of a global carbon budget. The research does not make a judgement on whether the changes are politically or economically possible (this would require further research and can be subject to rapid change). However, it is clear that such a transition would require a reversal of current trends in, for example, transport, which is politically challenging to say the least.

By "just" we mean: some chance of a safe climate for future generations; an equal distribution of the remaining global carbon budget between countries; and a transition in the UK in which the costs are distributed progressively, and where everyone's essential needs for housing, transport and energy use are met.

In this report we identify possible changes consistent with a carbon budget that gives a 70 per cent chance of not exceeding 2 degrees and a 25 per cent chance of avoiding a 1.5 degrees rise in temperatures over pre-industrial levels. Sharing a global carbon budget consistent with this risk means a carbon budget for the UK of 9 gigatonnes of carbon dioxide equivalent ($GtCO_2e$) for 2010-2049. A global carbon budget of this size still risks crossing tipping points, such as the melting of the Greenland ice sheet, so this carbon budget should be seen as a maximum.

The Department of Energy and Climate Change's 2050 Pathways model used and adapted in this research shows it might be theoretically possible to get close to this 9 $GtCO_2e$ budget but only with the substantial use of unproven negative emissions technologies (NETs) to take carbon out of the atmosphere and Herculean efforts across all sectors. A pathway which would do this would include reducing UK energy demand by 30 per cent by 2030 from current levels, almost totally decarbonising electricity supply by 2025 through rapid growth in renewable energy, some use of carbon capture and storage (CCS) in natural gas electricity plants and the use of energy storage, interconnections and demand shifting. No coal would be used to produce electricity after 2025 and natural gas use would be cut by 75 per cent by 2030. Aviation, shipping, and freight transport accounts for the vast bulk of the remaining fossil fuel use in 2050.

The research shows that to get very close to the target carbon budget would also need very significant behavioural change, such as: reduced consumption of meat and dairy products primarily to make land available for biomass production but also to reduce agricultural emissions; a reduction in air miles flown; significant modal shift in surface transport; average temperature of homes maintained at 17°C; and reduced product consumption (eg widespread car sharing instead of individual ownership). These behavioural changes go against current trends and to achieve them would require political and public will that is currently lacking. Significant technological innovation is also required.

The research provides policy options for achieving these changes. It briefly considers what the social-justice implications of these policies could be, with a focus on low-income groups in the UK (ie not exploring race, age, disability, etc). We suggest that many of the policies might have positive social-justice impacts and most if not all of those that have negative impacts could be successfully mitigated. However, without careful policy design it is possible that some sections of society – for example rural communities – could be greatly affected.

We have not modelled the economic impacts of the changes (policy and real-world changes). Modelling by DECC for a slower transition suggests that if fossil fuel prices remain high (which is very likely) energy bills as a result of the energy transition might be lower than with business as usual; and they might be lower in the short as well as long-term. There could be major job gains – for example 70,000 direct jobs in local action to improve insulation of homes and retrofitting renewable power, although job losses in other areas – for example in reduced fossil fuel use – might offset these gains.

Tackling climate change, the need for energy security and competition for diminishing levels of oil mean business as usual is not possible. Whether the speed and scale of changes suggested in this report are possible in practice is highly dependent on political and public will.

The main conclusion from this research is that the UK might, theoretically and with Herculean efforts, be able to make a transition to a low-carbon economy within the global carbon limit defined as 'safe' in this report; but this could only be done with the use of unproven NETs as well as mitigation. To do all this requires enormous changes in every sector much faster than currently contemplated by politicians and the public. To do so without negative social-justice impacts will require a determined effort to introduce a just policy pathway to reduce inequalities. Achieving majority public support for the changes would also require massive efforts.

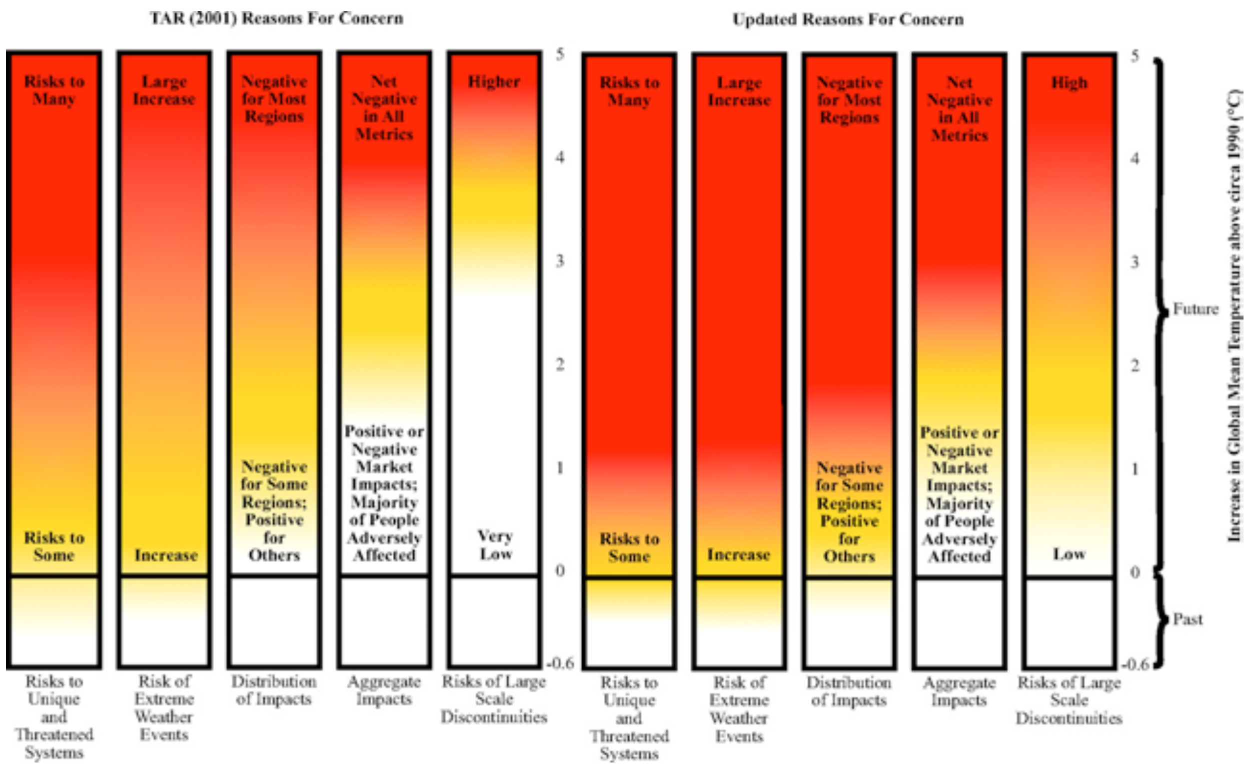
Some might say the scale and speed of change required is not politically, economically or socially possible. This is not an unreasonable conclusion. But if true then society will either need to accept a greater risk of dangerous climate change, with the social justice implication this brings, or consider much greater use of negative emissions technologies than modelled in this report. It would be wrong, however, to bank on negative emissions technologies to significantly reduce mitigation efforts. NETs will have their limits and might also be very expensive (this is the subject of further research by Friends of the Earth).

SECTION 1
BACKGROUND TO CARBON LIMITS

Research published in 2009 identified that the risks to biodiversity, to economies, to people across the globe, and of extreme weather events had significantly increased at lower levels of global warming than was previously thought.[1] Most worryingly the research identified the increased risk of large-scale discontinuities or tipping points at global average temperature increases as low as 1.5ºC (Diagram 1). Large-scale discontinuities include irreversible melting of the West Antarctic or Greenland ice sheets and reduction of the Gulf Stream. Crossing these tipping points could lead to unstoppable sea level rises of 10 metres or more with devastating impacts on communities and economies across the globe. The research clearly implied that dangerous climate change starts at a lower temperature than previously thought. Governments had previously said this temperature was 2ºC. A target of 1.5ºC or less would now be more appropriate.

Diagram 1 – the Burning Embers diagram. White = neutral or no risk, Yellow = negative impacts for some systems or more significant risks, Red = substantial negative impacts or risks that are more widespread and/or severe

RISKS FROM CLIMATE CHANGE, BY REASON FOR CONCERN – 2001 COMPARED WITH UPDATED DATA.



Smith J B et al. PNAS 2009;106:4133-4137

PNAS

In December 2010 Friends of the Earth published research into the limit on carbon emissions between now and 2050 to give at least a slim chance of avoiding a global average temperature increase of 1.5 degrees.[2] It identified that a global carbon budget of 1,100 $GtCO_2e$ between 2010 and 2049 gives a 25 per cent chance of avoiding a rise of 1.5 degrees and a 70 per cent chance of avoiding 2 degrees. Given that global emissions between 2000 and 2010 were 400 $GtCO_2e$ and the trajectory of emissions is upwards this carbon budget is very small.

If the 1,100 $GtCO_2e$ carbon budget is shared out equally between countries based on their populations, and ignoring embedded emissions in imports and exports, it implies very significant reductions in emissions in rich countries (Table 1) but also significant action to constrain and then reduce emissions in developing countries (Table 2). For example, China's emissions would need to peak by 2013 and then reduce by 5 per cent per year.

For the purpose of this research we have used the UK's equal share of this global carbon budget. By doing this we have excluded taking account of historical emissions, thereby significantly favouring the UK.

Table 1 – UK/EU/United States/global cuts on 1990 levels. This sharing of a 1,100 $GtCO_2e$ global budget implies the following per cent reductions on 1990 levels

	UK [12]	USA	EU	Global
2020	-56%	-74%	-60%	+2%
2030	-80%	-95%	-83%	-16%
2050	-96%	-100%	-100%	-68%

Table 2 – Emissions reductions for individual countries based on an equal sharing of a 1,100 $GtCO_2e$ 2010-2049 global budget, assuming no negative emissions

Country	Carbon budget 2010-2049 ($GtCO_2e$)	Peak year	Trajectory – annual percentage change in emissions
Very high per capita emitting countries			
United States	49.2	2010	> -15a year
Saudi Arabia	4.8	2010	> -15 a year
Russia	17.4	2010	> -15 a year
Australia	3.4	2010	> -15 a year
Canada	5.3	2010	-15 a year
Japan	15.7	2010	-10 a year
High per capita emitting countries			
South Korea	6.5	2010	-10 a year
Czech Republic	1.4	2010	-10 a year
Germany	10.4	2010	-9.5 a year
Poland	4.8	2010	-8 a year
EU	67.5	2010	-8 a year
UK	9.1	2010	-7.5 a year
Eire	0.7	2010	-7 a year
Medium per capita emitting countries			
Slovakia	0.7	2010	-6 a year
Hungary	1.3	2010	-5 a year
Italy	8.0	2010	-5 a year
Sweden	1.3	2010	-4.5 a year
Mexico	16.7	2013	+5 a year to 2013, then -5 a year afterwards
China	193.1	2013	+5 a year to 2013, then -5 a year afterwards
Chile	2.6	2014	+5 a year to 2014, then -5 a year afterwards
Thailand	9.7	2014	+5 a year to 2014, then -5 a year afterwards
South Africa	7.3	2015	+5 a year to 2015, then -5 a year afterwards
Syria	4.0	2016	+5 a year to 2016, then -5 a year afterwards
Low per capita emitting countries			
Tunisia	1.6	2020	+5 a year to 2020, then -5 a year afterwards
Brazil	28.7	2025	+5 a year to 2025, then -5 a year afterwards
Egypt	14.7	2025	+5 a year to 2025, then -5 a year afterwards
Indonesia	35.9	2028	+5 a year to 2028, then -5 a year afterwards
Peru	4.8	2032	+5 a year to 2032, then -5 a year afterwards
Very low per capita emitting countries			
India	195.8	2034	+5 a year to 2034, then -5 a year afterwards
Vietnam	13.9	2035	+5 a year to 2035, then -5 a year afterwards
El Salvador	1.0	2040	+5 a year to 2040, then -5 a year afterwards
Bolivia	1.7	After 2050	+5 a year
Pakistan	35.2	After 2050	+6 a year
Ghana	4.7	After 2050	+10 a year to 2035, then +5 a year afterwards
Sudan	8.1	After 2050	+10 a year to 2035, then +5 a year afterwards
Bangladesh	26.7	After 2050	+10 a year to 2041, then +5 a year afterwards
Uganda	8.2	After 2050	+15 a year to 2045, then +5 a year afterwards

One way to reduce the steep emissions reductions rates required in the UK to live within this global carbon budget is through the use of negative emissions (eg capturing and storing carbon from the air, reforestation, biomass power plants with carbon capture and storage, addition of bio-char to the soil). The use of negative emissions is not proven on a large scale and potentially brings risks.

For example, biomass CCS and large-scale bio-char production bring risks of land-use conflict with food production; and the technological difficulties and economic costs of capturing carbon from a network of small biomass plants are not well understood. Other ways of reducing the required rate of UK emission cuts are described in Box 1 below.

Box 1 – methods for reducing emissions reductions rate in UK

Method	Comment
Negative emissions	Potential not fully understood and technologies not fully developed. Some technologies are potentially beneficial and others bring significant social justice risks such as increased food prices.
UK given greater share of global budget	UK already favoured in allocation through ignoring historical emissions, and to give the UK a greater share would be unfair to developing countries' needs for industrial growth and transportation.
Take greater risk of exceeding 1.5 or 2 degrees	Greater risks of crossing irreversible tipping point
Allow temporary overshoot of carbon budget with natural decline over subsequent years	Science very uncertain, risks atmospheric carbon concentrations not declining in practice and/or crossing irreversible tipping points
Use Solar radiation management geo-engineering to cool the planet	High risk because all we currently know is that the potential negative impacts could be severe

SECTION 2

MODELLING REAL-WORLD CHANGES

Methodology

To identify how the UK could live within its carbon budget of 9 $GtCO_2e$ we have used the recently updated Department of Energy and Climate Change (DECC) 2050 Pathways Model.[3] The model allows users to create changes in all sectors of the energy economy based on four different levels of ambition which have been predetermined by DECC working with a range of stakeholders (level 4 being the most ambitious and described as 'heroic').

In a few areas Friends of the Earth has calculated the impact of increased ambition beyond level 4 but in the vast majority of areas we chose pre-existing levels within the DECC model.

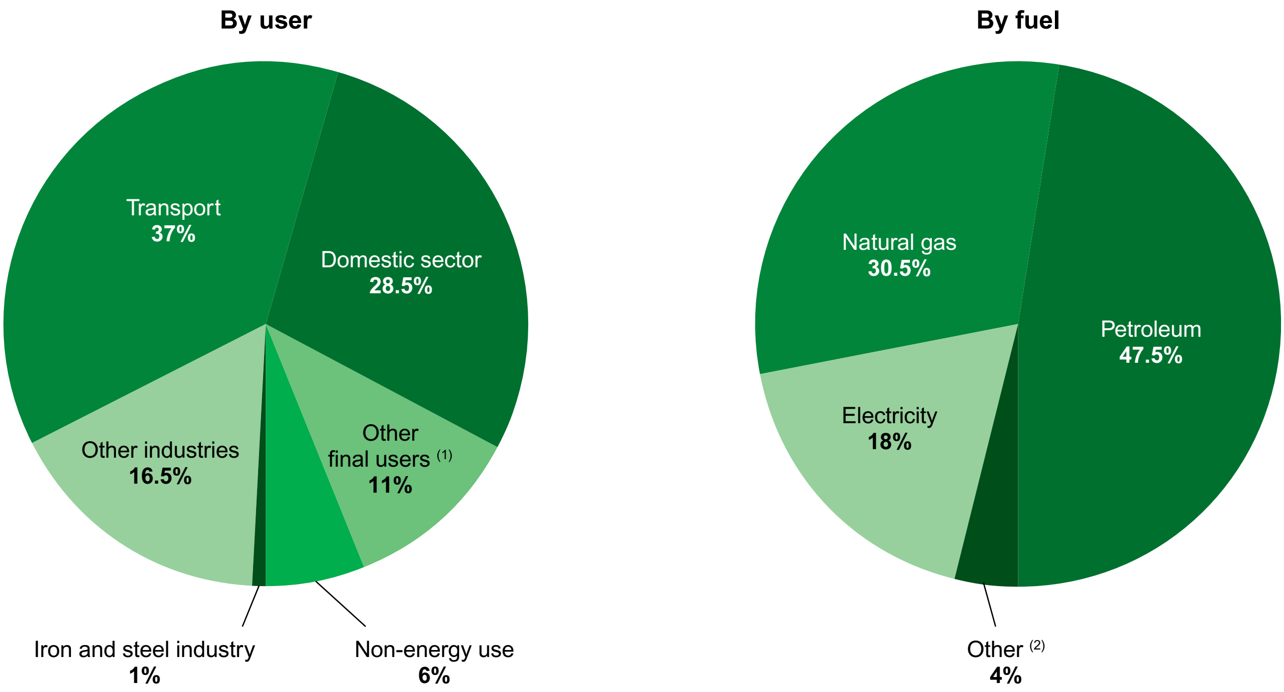
The DECC model is not perfect but our experience of using it gives us confidence that it produces a reasonable assessment of possible pathways, notwithstanding the changes we model in a few areas.

It is important to note that the model is not an economic model and therefore the economic impacts of the choices made are not known (ie impact on GDP, jobs, etc).

Changes

Diagram 2 shows current energy used by sector and which fuels are consumed.

Diagram 2 – Final energy consumption 2009



Total – 152.7million tonnes of oil equivalent

(1) Includes services and agricultural sectors
(2) Includes coal, manufactured fuels, biomass etc.

Sector changes and cross-cutting changes

To maximise carbon reductions, which is necessary to get anywhere close to the target carbon budget, it is necessary to maximise energy efficiency. Electrification of transport and heating is also needed, because this makes it possible to decarbonise the supply of energy needed for these purposes. We have chosen to provide the electricity needed in the future through renewable sources and excluded conventional nuclear power out of justice considerations for future generations as a result of the long-lived waste and concerns regarding nuclear proliferation. As can be seen below this does not have a significant impact on carbon emissions. Theoretically of course it is possible to use nuclear power to meet future electricity needs, potentially even one day through thorium nuclear reactors that bring much reduced waste and proliferation challenges.

The major changes to the energy system we first modelled are described below. All are DECC level 4 (DL4) unless otherwise specified (eg DL3).

Domestic

All consumer electronics and home computing products are most energy efficient throughout the period, with 75 per cent less energy per home for lighting and appliances. Average winter house temperature is maintained at 17°C (approximately same as currently, ie increasing trend ceases, although internal insulation could result in individual rooms being warmer) (DL3). Improvements in energy efficiency are close to what DECC says is the maximum physically possible (see Table 3 below). Energy for space heating is provided within the domestic and commercial sectors through 88 per cent electric (principally air-source and ground-source heat pumps), 11 per cent power station combined heat and power (CHP) and 1 per cent geothermal energy.

Personal surface transport

A modal shift to public transport and cycling accounts for 36 per cent of all distance travelled by 2050 and travel by car accounts for only 62 per cent with increased car sharing (currently 84 per cent of mileage is by car). Despite population growth passenger miles would be 5 per cent lower in 2050 than now. The majority of surface passenger transport is electrified. The total distance people travel remains the same as today's levels.

Freight

Freight modal share changes to 50 per cent road (currently 65 per cent), with rail 23 per cent (9 per cent), water 23 per cent (22 per cent) and pipeline 4 per cent (5 per cent); and the volume of freight grows less quickly than GDP (10 per cent drop in goods moved per person by 2050 compared to 2007).

Aviation

Annual improvements in international aviation fleet fuel efficiency of 0.8 per cent with doubling of passenger demand, and a growth factor of 2.2 in international shipping with a 40 per cent efficiency improvement by 2050 (DL1).

Heavy industry

A 40 per cent improvement in energy efficiency in heavy industry with electricity used for two-thirds of energy use and CCS in industry rolled out after 2025. Industry grows in line with trends (DL3). This change is broadly in line with the technical potential identified to the Committee on Climate Change by AEA Technology in December 2010.[5]

Onshore wind

Ten times the current number of on-shore wind turbines. Once significant levels of marine renewables have been built then some or all on-shore wind could begin decommissioning if local populations choose to do so, although once built they tend to be popular and failure to re-commission would be a waste of infrastructure (access roads, grid connections, etc).

Marine renewables

A massive growth in marine renewables with 17,000 wind turbines, mainly in the North Sea, 600 km of new wave farms, mainly off North West Scotland beyond the Hebrides, and tidal energy significantly utilised (DL3). Much of this would produce excess electricity which could be used for export or for storage for long periods of low wind, typically seen in the winter (for example, as compressed hydrogen storage to be used with open cycle hydrogen turbines).

Solar

All suitable domestic and non-domestic roofs and facades are used for solar PV with some land-based installations. All suitable buildings get 60 per cent of hot water demand through solar thermal. In addition geothermal energy is used for electricity production.

Fossil fuel electricity generation

For electricity generation plant, coal use is eliminated by 2025 and gas use decreased by 75 per cent by 2030 (remaining fitted with CCS).

Agriculture

A 20 per cent reduction in livestock numbers (400,000 less cattle) to directly reduce agricultural emissions and free up land for biomass production.

Making all of these changes, which will be difficult to achieve, reduces carbon emissions to 13.5 $GTCO_2e$, 50 per cent above the 9 $GTCO_2e$ carbon budget. Therefore we have modelled further possible changes in an attempt close this gap of 4.5 $GtCO_2e$. The changes modelled are outlined in Table 4.

Table 3 – Level 4 take-up of insulation measures

Measure	Number of UK households receiving measures	Year installations complete	Fraction of 2007 potential addressed on completion of roll out
Solid wall insulation (internal or external)	7,659,250	2040	96%
Cavity wall insulation	8,755,936	2030	96%
Floor insulation	11,387,501	2050	96%
Triple glazing equivalent	22,641,032	2050	96%
Loft insulation	21,439,968	2040	96%
Improved air-tightness	24,050,381	2020	96%

Table 4 – Additional changes modelled in order to reduce the 4.5 $GtCO_2e$ gap

Change by 2050	Explanation	Reduction on carbon budget
International aviation emissions capped at 2005 levels	Significant expansion of aviation is not possible without the use of fossil fuels even if sustainable bio-fuels are technically possible at some future date, because bio-fuel availability will be limited due to requirements of land for food crops and biodiversity protection. We therefore modelled international aviation emissions at current levels. This choice is not available in the DECC model.	0.4 $GTCO_2e$
International aviation emissions reduced by 50 per cent from 2007 levels	Emissions in 2050 are half the 2007 level. This level can be reached by immediate annual reductions starting at -1.5 per cent per annum, increasing to -2.4 per cent in late 2020s and flattening off from 2030s onwards. This would require significantly fewer flights. The exact reduction is dependent on carbon efficiency gains in aviation.	0.7 $GTCO_2e$
Increasing marine renewables to highest level in DECC model	This leads to faster deployment of renewables but also creates significant excess electricity which could be exported or stored (for example as hydrogen).	0.3 $GTCO_2e$
Reduce car travel faster	DECC level 4 is already ambitious. We found that accelerated action has minimal impact. For example, the level 4 trajectory in the DECC model has bus share (of total passenger km) increasing gradually from 7 per cent to 19 per cent and rail share from 7 per cent to 10 per cent. If instead we increased bus share immediately over the next five years to 14 per cent and continued to increase it to 25 per cent at 2050, and rail share from 7 per cent to 10 per cent in the next five years and then to 15 per cent at 2050, the total saving is only 67 Mt	0.07$GTCO_2e$ (not significant)

Table 4 – continued overleaf

Table 4 – cont

Change by 2050	Explanation	Reduction on carbon budget
Reduce livestock numbers further and produce 1 to 2 million hectares of biomass in additional to current levels	A report by Cranfield University for the Committee on Climate Change suggested that a reduction of 50 per cent in livestock production could free up several million hectares of land for other uses.[6] Friends of the Earth would prioritise using this land to reduce overseas land use for food and feedstock. Further research is needed in this area to identify whether this still allows increased biomass production. Notwithstanding this we have identified what a 1 or 2 million hectare increase in land for biomass may mean in carbon terms. Reducing meat consumption brings health benefits.	0.2 $GTCO_2e$ (1 million hectares) 0.6 $GTCO_2e$ (2 million hectares)
Reduce average temperature of homes to 16°C	Delivering this change, and potentially an average 17°C temperature, would require greater use of internal room insulation so that frequently used rooms (eg lounge) are kept warmer than other parts of the house, especially for elderly or other vulnerable occupants.	0.1 $GTCO_2e$ (not significant)
Reduce heavy industry size through dematerialisation in addition to improved efficiency.	Significant reduction in resource consumption may be possible without reducing quality of life, for example, much greater levels of car sharing, lightweight products, longer-life products, use of lower-carbon materials. These changes may reduce the need for heavy industry considerably. A report by AEA Technology identified that around a 15 per cent reduction may be made in steel use through extending product life and a further 15 per cent through reuse.[5] This excludes the potential to reduce demand by buying fewer products (eg car sharing). The ability to down-size heavy industry in the UK at the same time as producing a greater share of products in the UK is not known and needs further research. Here we have used the DECC scenario of heavy industry decreasing by 30-40 per cent. This is done for modelling purposes only and does not represent a current aspiration or policy objective of Friends of the Earth.	0.6 $GTCO_2e$
New nuclear power	Although Friends of the Earth does not support conventional nuclear power due to the justice implications of leaving highly radioactive waste for future generations and nuclear proliferation, we have modelled the impact of adding 13 nuclear power plants to the pathway. In this scenario this has negligible impact because it is competing with high levels of renewable electricity. In scenarios with much less renewable electricity it would make a much greater contribution by replacing coal or gas rather than competing with renewable power. Some have argued that nuclear power is needed as a non-intermittent energy supply instead of or in addition to tidal energy, biomass electricity, geothermal, and gas with CCS.	0.03 $GTCO_2e$ (not significant)
Faster implementation	Accelerating all the changes modelled so that 2010 emissions are halved by 2022 rather than 2025. The feasibility of this would require significant exploration.	0.3 $GtCO_2e$
Geo-sequestration	For example, addition of bio-char to soil, reforesting land, and potentially capture of carbon dioxide from air (technically unproven on a large scale, and with big energy implications). If maximised within the DECC model the contribution will be large. Friends of the Earth is carrying out further research into the potential for negative emissions.	1.4 $GTCO_2e$

The cumulative impact of the changes in Table 4 is that the carbon budget now stands at just under 10 $GtCO_2e$. Further reductions in addition to those above may be possible, and greater than 1 $GtCO_2e$ would be necessary if any of the changes identified above are not possible or desirable, such as:

- A faster transition from coal which would require increased gas but would deliver an additional 0.1 $GtCO_2e$ reduction. The UK has reduced its carbon emissions by 20 per cent from 1990 levels and the switch from coal to gas is the greatest contributing factor. Delivering a faster switch from coal may require new gas-fired power stations that then may need to close before the end of their design life once renewable energy takes over the production of electricity.
- Geothermal energy for district heating, which is not included within the DECC model. This might make a significant contribution over time although its greatest impact may be to reduce the need for so much electricity in heating, thus reducing the challenge of intermittency in cold windless winter periods. Greater amounts of district heating may also be possible.
- Even greater reductions in sectors where there are no obvious alternatives to fossil fuel use (aviation and shipping).
- Extending the life of some or all the current nuclear power plants by five years would make a minor contribution (less than 0.1 $GTCO_2e$) whilst intermittent and non-intermittent renewable power is built up. The safety implications for the oldest reactors would need careful consideration.
- Some imports of biomass from near European neighbours with large biomass potentials could be possible, although as renewable energy plans submitted to the European Commission illustrate, there will be strong competition for this (the UK could potentially trade the excess electricity we are able to produce from off-shore wind). Within this work we have excluded the import of biomass because of concerns about impacts on global food prices, biodiversity, and carbon emissions associated with production and transportation.

Our scenario uses significant levels of energy storage and grid interconnectors to mainland Europe to safeguard against energy shortages during long cold winter periods with limited wind (in shorter periods of no wind, options such as smart grids and smart heating/appliances can be used). Greater research into storage is needed. Compressed hydrogen together with open cycle hydrogen turbines look the most promising option.

We did not model a lower growth rate than 1 per cent per annum in houses assumed in the DECC model or a lower rate of population growth. It may or may not be possible to reverse the trend for more single homes. It may be possible to reduce second homes. UK population is forecast to rise due to longer lives and inward migration (fertility within the UK is already less than replacement rate.[7]

Box 2 – GDP

We did not model reduced GDP growth because the DECC model is not an economic model. There is a debate on whether reducing the rate of GDP to meet carbon budgets is necessary. Between 1990 and 2010 carbon dioxide emissions in the UK reduced by 20 per cent against a trend of increasing GDP but embedded emissions in imported products have more than offset this domestic reduction. This was largely achieved through fuel switching from coal to gas. Whether it is possible to continue high growth policies and meet global carbon budgets, taking into account domestic emissions and embedded emissions in imports, is highly questionable and requires further examination including of different growth strategies. A reduced rate of GDP growth does not necessarily mean lower quality of life.

SECTION 3

RESULTS AND DISCUSSION

The research presented here shows that herculean efforts are required across all sectors of the economy to give a theoretical chance for the UK to live within its share of the identified global carbon budget – and in addition significant levels of unproven NETs are also required. The scale of effort can be better appreciated when compared to current trends. For example:

- Total energy consumption has not significantly changed since 1970 (although fuel used has changed considerably);
- Since 1990 private car use has increased by 20 per cent and, since records were collected in 1994/95, walking and cycling have declined;
- The average energy efficiency of homes (the SAP rating) has improved but only slowly;
- Around 70 million people flew overseas from the UK in 2008 compared to only 18 million in 1980.
- Renewable energy still only provides a small proportion of electricity (7 per cent).

The results from the modelling carried out for this research are that energy demand is reduced by 25-30 per cent by 2030 from 2010 levels and 30-45 per cent by 2050, despite a growing population and more homes (the higher figures apply if the additional action on sectors in Table 4 is implemented).

By 2025 electricity is almost totally decarbonised. Excess electricity can be used in energy storage, or could be exported. By 2030 around 30 per cent of all energy use is from electricity and up to 40 per cent by 2050. Use of oil in aviation, shipping, and freight transport accounts for around 90 per cent of the remaining fossil fuel use in 2050 even if international aviation emissions are capped at 2007 levels.

Table 5 – Energy use (TWhr/yr)

Sector	2010	2020	2030	2040	2050
Lighting and appliances	158	143	131	122	116
Heating and cooling	493	413	364	337	328
Industry (if smaller through dematerialisation)	465	416 (357)	377 (285)	346 (229)	320(186)
Transport (with international aviation emissions at 2007 levels)	702	649 (635)	499 (476)	478 (438)	458 (403)
Total	1,818	1,621 (1548)	1,371 (1256)	1,283 (1126)	1,222 (1033)

Table 6 – Energy supply (TWhr/yr) – excess energy could be exported, used in storage, or lower levels of capacity built

Source	2010	2020	2030	2040	2050
Bio-energy (if 1-2 million extra hectares of land for biomass)	97	148 (157-229)	131 (181-264)	122 (211-310)	116 (218-342)
Environmental heat (heat pumps)		46	101	113	109
Wave			7	30	70
Wind	16	173	501	859	1061
Solar	6	48	177	220	256
Geothermal			35	35	35
Hydroelectric			8	8	8
Tidal					39
Coal	388	122	0		
Gas	904	475	167	62	0
Oil [1]	852	744	525	461	400
Total	2263	1,756 (1,765-1,837)	1,683 (1,702-1,785)	1,956 (1,999-2,098)	2,134 (2,196-2,320)

[1] In 2050 around 40 per cent of oil is used in aviation (when emissions capped at 2007 levels), 30 per cent in shipping, 15 per cent in industry and 10 per cent in road transport. Oil use is reduced by up to 25 per cent by 2050 if increased bio-energy production.

To live within the 9 $GtCO_2e$ carbon budget the UK will require significant amounts of negative emissions (geo-sequestration). We do not yet know whether this is going to be possible. We will also have to significantly reduce meat and dairy consumption (unless synthetic meat becomes available) for which there are no obvious policy levers that are politically palatable. We will also have to transform buildings, transport and energy production.

It is extremely difficult to envisage such a rapid change given current political and public will. In fact even pushing for these changes may create a negative backlash. Even Friends of the Earth does not yet support all the potential changes identified, for example downsizing industry, at least until much greater research is carried out. This suggests that whilst efforts should be made to significantly increase mitigation efforts, much greater attention needs to be given to gaining public acceptance for change. It also suggests that the development of negative emissions technologies should be pursued with vigour.

Diagram 3 – Energy use (TWhr/yr)

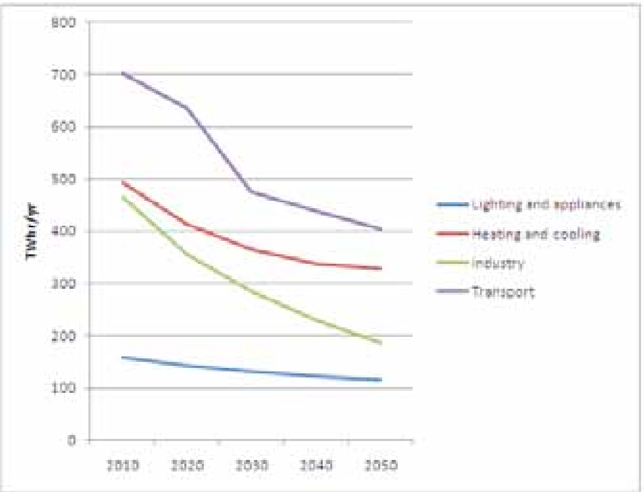
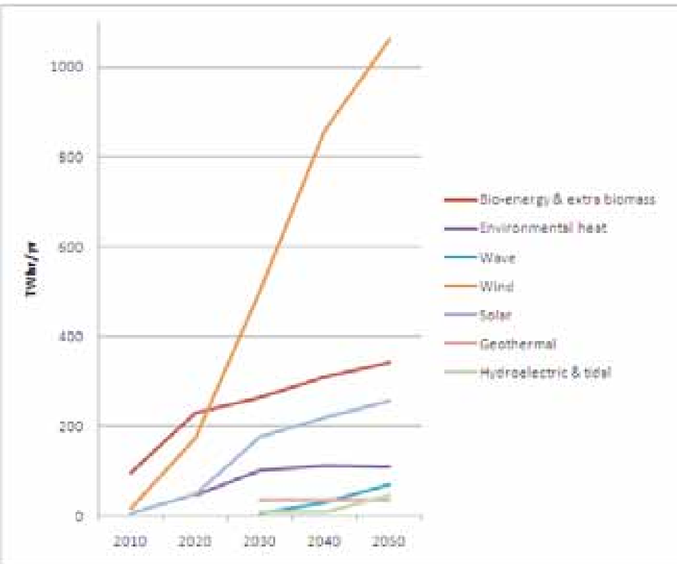
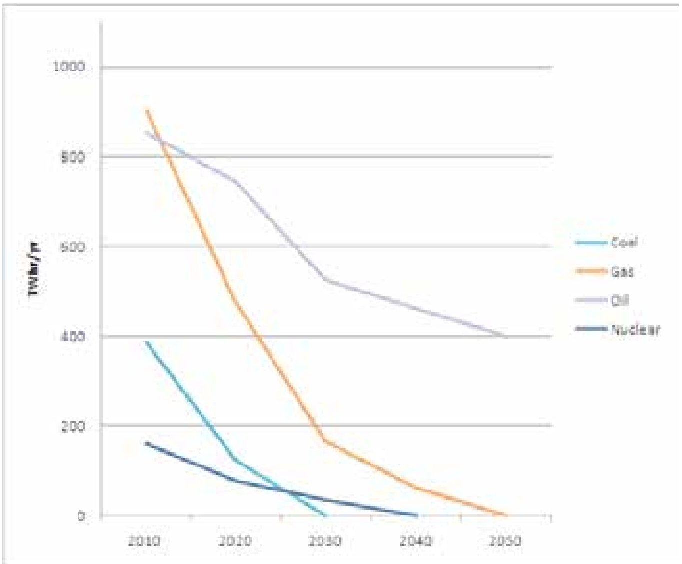


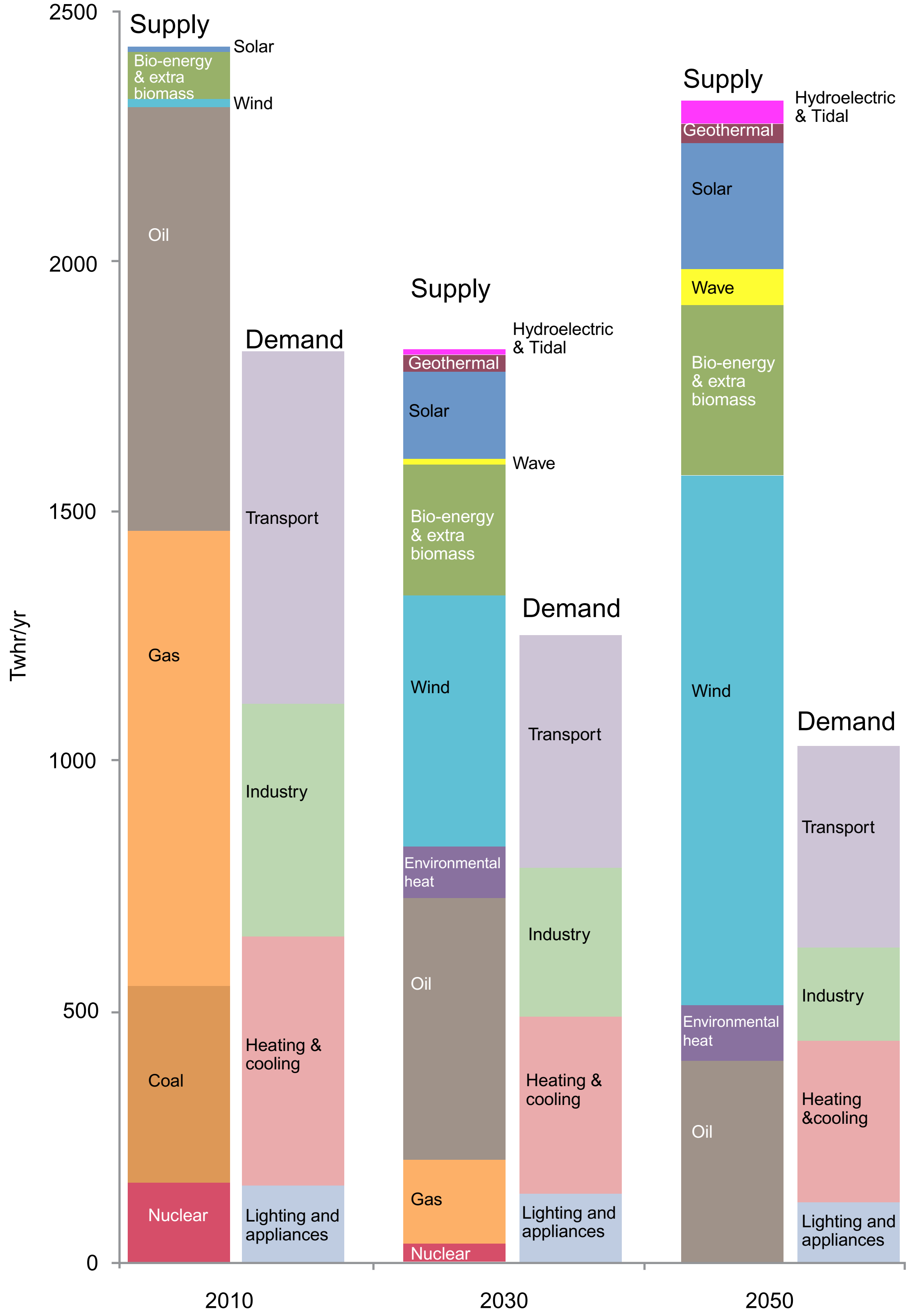
Diagram 4 – energy supply (TWhr/yr)





- Excess energy could be exported, used in storage, or lower levels of capacity built.
- In 2050 around 40 per cent of oil is used in aviation (when emissions capped at 2007 levels), 30 per cent in shipping, 15 per cent in industry and 10 per cent in road transport. Oil use is reduced by up to 25 per cent by 2050 if increased bio-energy production.

Diagram 5 – energy supply (TWhr/yr)



• Excess energy could be exported, used in storage, or lower levels of capacity built.

SECTION 4

POLICY OPTIONS

None of the changes suggested in this research are inherently socially regressive. Warmer homes, greater use of public transport, reduced jobs in one sector but increased jobs in another, fewer flights, etc can all be socially progressive if the right policies are chosen to deliver them. But they could also be socially regressive if they are, for example, solely driven by taxes on fuel. Whether the changes are progressive or regressive largely depends on the policies chosen to deliver them.

Our policy experts, aided by peer review, have suggested some policy options for achieving the changes required. Undoubtedly other policy options exist. Those identified here are designed to achieve carbon reductions in line with the carbon budget and be fair on low-income groups in the UK.

The policy changes are substantial, which is not surprising given the scale of change needed to live within the carbon budget. In every area the level of policy intervention is much greater than that currently supported by the Government, although in the same direction of travel in nearly all areas.

We have identified three types of policy. These are economic, regulatory, and soft (such as education).

It was not the purpose of this research project to produce a comprehensive policy pathway to a low-carbon economy. However, a broad-brush illustration of the possible policy changes and a brief qualitative assessment of possible social justice impacts have been made. The policy options identified do not necessarily represent Friends of the Earth policy positions.

Housing

- Economic – grants and loans for energy efficiency (including individual room insulation for vulnerable households), energy tariff changes so that initial energy usage is at a low price and higher energy usage more expensive.
- Regulatory – strong EU eco-design directive, minimum standards for homes (new and existing), requirement for the Government to eradicate fuel poverty, and introduction of requirement for local authority action on climate change.
- Soft – smart metering, free energy surveys, education.
- Social justice impact – in theory very positive through less fuel poverty and healthier homes. The Government's Green Deal legislation, currently going through Parliament, aims at delivering a substantial energy-efficiency programme through loans to householders (paid back by reduced energy costs) and grants from energy companies targeted at vulnerable households and hard-to-treat properties. The Energy Savings Trust has said that 80 per cent of homes can be improved to band D for less than £3,500 and this would save householders on average £437 per year. Twelve per cent of homes would cost more than £7,500 and 0.2 per cent over £23,000. To achieve the reductions suggested by this report would need more significant improvement over a longer period of time. This would lead to much longer payback periods. The length of the payback period is highly dependent on the fossil fuel price but even with conservative estimates should be within 20 years. Funds could be found from, for example, receipts from the planned emissions trading scheme permit auctions. Other research has suggested housing retrofitting will be a strong job creator.[8] Targeted care is needed for the small number of low-income high energy users who could lose due to energy tariff changes.

Non-domestic properties

- Economic – provide SMEs (small and medium enterprises) with low-interest loans and grants, carbon tax for larger businesses.
- Regulatory – building standards for retrofits and new buildings.
- Soft – free advice from Energy Savings Trust / Carbon Trust.
- Social justice impact – no significant impact because research has consistently shown that businesses can reduce costs through better energy efficiency.

Surface transport

- Economic – national road user charging, investment in rail, bus, coach and electric car infrastructure, subsidies for public transport and purchase of electric cars, incentives for car-sharing. Very significant investment in cycling and walking.
- Regulatory – significantly strengthen EU car and van CO_2 standards, land use planning, lower speed limits to constrain growth in miles travelled and reduce travel emissions.
- Soft – smarter travel choices approaches pursued with vigour, car sharing.
- Social justice impact – potentially significantly negative on low-income people in rural communities and low-income car users elsewhere where cars are necessary for accessing activities (these people are already highly susceptible to higher fossil fuel prices). Requiring better vehicle design will ameliorate this impact but only over time.

This sector would require substantial investment in alternatives to the car if justice issues are to be dealt with (for example, grants to make car-sharing clubs for electric cars in rural areas attractive and economically viable, more effective demand-responsive public transport options). Subsidies raised should be via general taxation and reduced expenditure from road building rather than regressive measures such as VAT increases. The costs of this transition are not clear and need further work, although it is widely recognised that further road building, which is the approach favoured by some others, is very expensive. The running cost of fossil fuel cars will increase considerably as fossil fuel prices increase.

The shift to better public transport is positive for young people and those without a car.

Freight

- Economic – research into engine design, and subsidies for rail and water freight.
- Regulatory changes – plan for increased rail and waterways capacity, strengthen freight operator licences, significantly strengthen vehicle efficiency standards for HGVs.
- Soft – encourage use of IT for lorry sharing, league tables on retailers' performance.
- Social justice impact – no obvious impact on low-income groups.

Aviation

- Economic – fuel taxes, per plane tax, increase air passenger taxes for each individual flying more than once per person per year, subsidies for long-distance rail travel.
- Regulatory – rationing of flights (eg one flight per family per year or less), no new runways, dedicated closed Emissions Trading Scheme with declining budget.
- Soft – European rail companies provide seamless timetables and ticketing, strengthening of electronic forms of interaction.
- Social justice impact – potentially negative for some low-income immigrant families as increased costs reduce opportunities to visit distant relatives, although strengthened electronic communication would bring benefits. If economic measures are used instead of rationing then inequalities would increase as access to flying would be further out of reach of low-income families. Rationing would reduce inequalities in access to aviation but would be politically more difficult to achieve. Positive for UK tourism and jobs, some of which may be in deprived seaside communities and create increased income for low-income people. Low-income people tend not to fly.

Heavy industry

- Economic – financial support for emerging technologies (eg marine renewables), skills training for transition, EU border carbon adjustment tax to encourage UK/EU production, financial incentives for improving resource efficiency, materials taxes and other incentives to encourage dematerialisation (eg car sharing, grants for tool sharing clubs, Freecycle).
- Regulatory – planning policy ensures national infrastructure (eg for marine renewables) built on time, product policy focused on dematerialisation.
- Soft changes – research and development in key sectors.
- Social justice impact – potentially significant job reductions in heavy industry and related industries due to reductions in resource use. There has been considerable research identifying new jobs as a result of increased energy efficiency or supply chains for new renewable power (for example: the Offshore Valuation Group has suggested 145,000 new jobs through the development of renewable power), some of which will be in heavy industry. Although the renewables industry will be a major consumer of steel and cement, and some heavy industry locations are already reinventing themselves as providers to the low-carbon economy, it is also possible that many of the new jobs created will be in different locations and require new skills. Therefore training and careful transition is required. Friends of the Earth is not advocating this down-sizing of industry until the impacts of such a significant reduction in heavy industry are better known, and the provisions needed to re-skill and redeploy workers are agreed.

Waste

- Economic – continuation of landfill tax escalator, increase price of incineration of residues, reduce cost of landfillling residuals from recycling, and subsidies for reuse.
- Regulatory – requirements for collection of more materials from households through separate collection (eg food waste), proximity principle applied in location of waste treatment sites.
- Social justice impact – waste treatment plants are often located in low-income communities, which would be curbed by application of proximity principle in planning (ie locations not concentrated in poorer areas, size of plants constrained).

Nuclear

- Economic – removal of subsidies for conventional nuclear power, research funds for Thorium nuclear reactors from funds removed from nuclear fusion.
- Regulation – Energy National Policy Statement prioritises renewables and

energy saving.
- Soft – political promises on priority to renewables and energy saving.
- Social justice impact – negative for communities near existing plants due to job losses as nuclear energy contribution declines over time, thus may create more people with low income. Positive for future generations due to less long-lived radioactive waste.

On-shore wind
- Economic – support for smaller-scale renewables (<10MW).
- Regulatory – presumption in favour of permissions in planning policy.
- Soft – promotion of community and municipal ownership.
- Social justice impact – positive if low-income families benefit from community ownership or benefits provided by supply companies.

Off-shore wind
- Economic changes – electricity market reform prioritises German-style fixed feed-in tariff for marine renewables, investment in ports infrastructure and international grid.
- Regulatory changes – priority access to the grid.
- Soft – skills training.
- Social justice impact – positive for employment.

Tidal, wave and tidal stream
- Economic – feed-in tariff regime, research and development.
- Regulatory – priority access to North Sea ahead of oil and gas.
- Soft – research and development.
- Social justice impact – positive for employment.

Decentralised energy
- Economic – government support for geothermal demonstration projects, maintenance and extension of FIT/RHI subsidies with greater financial resources.
- Regulatory – local carbon budgets, CHP mandatory on thermal power plants.
- Soft – free comprehensive advice pack on setting up community-owned decentralised energy company.
- Social justice impact – potential to be positive for low-income groups if used by local authorities and housing associations; new subsidies should be paid for though general taxation, not fuel levy (as is the case with the RHI).

Storage and back-up
- Economic –investment in international grids, financial incentives to maintain back-up of low-carbon supply (eg hydrogen storage) for extended periods of low wind.
- Regulatory – planning policy on grid transmission lines (presumption in favour), requirement for electricity distribution companies to upgrade grid (eg for use of electric cars batteries for back-up).
- Soft – research into electric car batteries and other options (eg hydrogen) for storage.
- Social justice impact – some increase in energy bills although the Committee on Climate Change has suggested that this increase is minimal (less than 1 pence per KWh.).

Agriculture, diet, land use and biomass
- Economic – shift farming subsidies.
- Regulatory – ban imports of biomass from outside EU, scrap current targets and subsidies for transport bio-fuels and instead focus biomass for high-priority uses where other renewables cannot provide energy (eg heavy industry).
- Soft – promotion of sustainable diet and local authority, NHS and other public sector procurement policies based on healthy standards.
- Social justice impact – jobs impact on farmers, some of whom live on low incomes, from reduced livestock, could potentially be more than offset by increased jobs in more sustainable farming and biomass production.

Negative emissions technologies
- Economic – publicly funded research into lower risk technologies.
- Regulatory – work internationally on governance and regulatory regime.
- Soft – begin public debate onnegative emissions technologies.
- Social justice impacts – currently unknown, potentially severe for some technologies.

Cross-cutting economic
- Economic – end subsidies to fossil fuels, using some of the money to reduce impact on low-income groups, use revenues of emissions trading scheme auction revenues in, for example, housing retrofits or car sharing in rural areas, make improving quality of life as primary objective of the Treasury.
- Regulatory – introduce proximity principle into planning policy to reduce transportation and increase community involvement in sector solutions.
- Social justice impacts – potential to be very progressive but if done badly could be regressive.

SOCIAL IMPACTS AND ADDRESSING THEM

Costs

There is a strong perception that the shift to a low carbon economy will result in higher fuel bills which will disproportionately hit lower-income households and increase fuel poverty. It is true that the shift will result in higher fuel **prices** but it is also very possible that consumer energy **bills** will be lower than business as usual. This is because business as usual maintains a high dependency on fossil fuels whose price is rising fast, and poor energy efficiency.

The table below from DECC illustrates this.

	2020 bill (prices = real 2009 values)
Energy bill without policies, $80 barrel	£1,226
Energy bill with policies, $80 barrel	£1,239
Net impact of policies on energy bill	£13 (+1%)
Energy bill without policies, $150 barrel	£1,699
Energy bill with policies, $150 barrel	£1,612
Net impact of policies on energy bill	£-87 (-5%)

More recent research by the Committee on Climate Change suggested that the average energy bill in 2020 without renewables will be £1,360, with renewables will be £1,420 and with renewables plus energy efficiency will be £1,120. This is based on a conservative estimate of future fossil fuel prices. They also state this will hold in future decades.

Beyond 2020 costs for the different energy technologies are thought to be broadly similar even if fossil fuel prices remain low. If fossil fuel prices are high then renewable technologies will be comparatively cheaper.

There has been recent media coverage, for example in the Daily Mail, which suggests that 20 per cent of current energy bills are due to green policies. An analysis of these claims however shows this to be an exaggeration and that the impact is around 4 per cent.

It is important to note that these figures are based on a slower transition to a low carbon economy than the options presented in this report.

The transition in this report suggests a much greater use of solar power. Solar power is currently a more expensive form of renewable power although prices are tumbling fast and it is thought that in 10 years' time or less it will no longer need any subsidy. During these 10 years Friends of the Earth suggests any increased support for solar should be via measures other than energy prices.

Whether the changes outlined in this report are more or less expensive than business as usual very much depends on the price of fossil fuels.

In a poll of global energy company executives conducted this April by the KPMG Global Energy Institute, 64 per cent of those surveyed predicted that crude oil prices will cross the US$120 per barrel barrier before the end of 2011. Approximately one-third of them predicted that the price would go even higher, with 17 per cent believing it would reach $131-$140 per barrel; 9 per cent, $141-$150 per barrel; and 6 per cent, above the $150 mark. This would tend to suggest that even the faster transition suggested in this report is likely to result in lower bills than business as usual. Therefore it is possible that the greater threat to low-income households in the short and long-term is not a shift to low-carbon economy supplies but instead maintaining a heavy reliance on fossil fuels.

DECC is currently applying cost estimates to its pathways model used in this research and these will be published towards the end of 2011. This will enable a better assessment of different pathways.

Energy efficiency

In energy efficiency many of the changes required will pay for themselves within 10 years or less (eg loft insulation) but other measures will have a much longer payback period (eg solid wall insulation). How these changes are paid for is therefore of critical importance. Present Government policy is to require either:

- the householder to pay through a Green Deal Pay As You Save scheme which involves a loan paid back through reduced energy bills in the future; or
- the energy companies to carry out work in vulnerable households and more hard-to-treat properties through the Energy Company Obligation (which may or may not be supplemented by monies raised through other means, eg auctioning of emissions trading regime permits).

The former creates risks of consumers paying back large quantities of money for small changes in practice due to the length of the loan and the interest rate charges. The latter increases fuel energy bills, particularly as energy retail prices are not regulated (ie energy companies can easily pass on the costs). Green Deal Pay As You Save is an appropriate tool for middle-income households carrying out measures that generate fast payback times but it is not a particularly good vehicle for low-income groups unless accompanied by grants (which DECC is considering).

Friends of the Earth and other NGOs suggest that grants be made available for low-income households from energy companies and that works be carried out on a street-by-street, neighbourhood-by-neighbourhood approach. This will increase uptake and can reduce costs significantly.[9] Local authorities are well placed to facilitate this approach.

The changes in housing stock suggested are progressive, as long as average house temperatures are accompanied by insulation within the house to keep main living spaces warmer.

Improving the quality of the housing stock will not only improve the comfort level of homes but it will also generate real health benefits.[10]

Surface transport

A shift to electric cars, public transport, walking, and cycling, and shorter travel distances brings significant benefits to most groups.

Over the past 20 years or more the cost of motoring has declined in real terms whereas the cost of public transport has increased. This is because the cost of cars has declined significantly and fuel efficiency has improved whereas bus occupancy has decreased (increasing the costs per passenger). Decades of under-spending on rail infrastructure has also led to considerable expenditure over recent years driving up rail fares.

The shift to electric cars implies significant costs although the cost of electric cars will decline in future years due to improvements in battery technology and large-scale manufacture. The infrastructure costs for charging may also be very significant including revamping the grid (for other purposes as well as electric cars). Increasing infrastructure for rail and bus travel is likely to be very costly.

To achieve modal shift may require increases in fuel duty, as well as increased subsidies for public transport. It will require major social and cultural change. Although fuel duty income could be used to subsidise public transport, it will decline over time as cars become electrified (although the costs of public transport will also decline with more passengers).

Road user charging could provide a new income stream to pay for some of these changes, but additional monies are also probably needed. Reduced road expenditure can provide some of this income (a new road can cost over £100 million per mile). Increased subsidies from central and local government will also be necessary, raised from general taxation.

About a quarter of households in the UK do not have access to a car, nor do 65 per cent of single pensioners or more than half of the poorest households. The changes suggested in this research are therefore likely to be very progressive through much better and subsidised public transport (especially buses), walking and cycling facilities and the substantial growth of car-sharing. These changes can provide these people with better access to jobs, services and social networks.

However, for low-income or even middle-income car owners who depend on their car to get to work or access services or facilities, the changes may be very regressive at least until better public transport facilities exist (bus services are being cut at present). This is particularly true in rural areas. David Cameron has recently suggested that the Government will look at what help may be provided to rural communities to address this issue. The answer is likely to be complex and go beyond transport measures (for example targeted reductions in council tax). Measures required include better land-use planning, improved public transport services for rural areas and low-carbon taxi or car-share schemes. Friends of the Earth suggests grants for more efficient cars, rural Smarter Choices (smarter public transport and better information), grants for car sharing, demand-responsive public transport, video conferencing, home working, IT office hubs in villages, and action to protect and enhance rural services such as shops, post offices and doctors' surgeries, all of which can help mitigate impacts.

Aviation

Aviation policy is always a controversial area. The number of people flying has increased considerable over the past 10 years with the advent of low-cost airlines. Flying is however still largely the preserve of the rich (the mean income of flyers at budget airport Stansted was £48,000 in 2009). Aviation prices are very low but low-income households are deterred from flying by the costs of accommodation etc at the destination. Many immigrant families and their descendants do fly to visit distant families.

One method of reducing flying is through the use of aviation taxes. Although these will hit the richest hardest, as these are the people that fly most, it will put access to flying further out of the reach of low-income families (although as mentioned the costs at the destination are often prohibitive). A rationing system for the current 70 million flights (but declining in number as the carbon budget gets smaller) would be a more progressive approach, although politically more difficult to achieve.

Decentralised energy supply

Currently generating renewable energy is more expensive than fossil fuel energy. But as technologies develop the costs of renewable power will fall significantly whereas the cost of fossil fuel energy could rise substantially. On-shore wind is expected to be the lowest cost low-carbon energy supply in the near to medium term.[11]

The introduction of a feed-in tariff in the UK for small-scale electricity production has created much debate because a) the costs of this type of production are at present much more expensive than other low-carbon options; b) the costs of supplying the subsidy are passed on to consumers on energy bills; and c) the need for capital to purchase small-scale renewable power can close off this option for low-income households. Again, small-scale electricity production will get much cheaper as time passes due to economies of scale – bringing down costs is a central purpose of feed-in-tariffs, as has been successfully demonstrated in Germany.

Using the DECC model demonstrates that because small-scale renewable energy can be built fast, it has an important role in quickly reducing carbon emissions. Friends of the Earth recommends that serious consideration be given to paying any increase in the feed-in tariff budget through general taxation, as with the renewable heat incentive. Low-cost capital should also be made available for low-income households so that they can take advantage of the scheme, potentially with local authorities or social housing providers. Friends of the Earth encourages communities to get together to use this scheme. There are already some examples of where this has worked well and the process of developing community-owned energy production assets has also created stronger communities

Diet

It is difficult to see how reduced meat and dairy consumption can be achieved through policy change (technical changes, such as the production of synthetic meat may be some way off and consumer acceptability is unknown). Friends of the Earth does not have any ready answers to this challenge, but as the research shows we need to find a way of increasing biomass availability if we are to reduce emissions in line with the carbon budget target.

Energy tariffs

Fuel poverty campaigners suggest that the tariff rate charged by energy companies must change. Currently the initial use of energy for householders is more expensive and it gets cheaper as more is used. This clearly favours high energy users and penalises low energy users. This tariff rate should be reversed, although mitigation would be required for the small proportion of households that are low-income but high energy users (for example those with medical conditions).

As already discussed, energy bills will increase in the future either due to higher fossil fuel prices or increasing use of renewables, but a package of aggressive energy efficiency will constrain the impact of these increases. It is likely high use of renewables in future will result in lower bills than will reliance on fossil fuels (fossil fuel dependency has remained at 90 per cent for the last 20 years). Sir David King, former Chief Scientific Advisor to the Government, warned that governments have their heads in the sand over dwindling oil supplies and that forecast reserves are exaggerated by around 30 per cent.[12]

SECTION 6
CONCLUSIONS

A business-as-usual approach to the UK's energy use and production is not viable as it will cost the poorest in society due to increased fossil fuel prices and climate change impacts (which hits the poorest hardest in both developed and, especially, developing countries).). Neither is a much slower transition through reducing emissions by first undertaking energy-demand measures and only then developing more expensive energy-supply measures as this will lead to significant levels of climate change with significant social justice impacts. These approaches, if also followed by other countries, lead to much higher climate change damage and far higher risks of passing tipping points. They would also fail to address energy security concerns and lead to higher energy prices as oil supplies dwindle and global competition for them increases.

The implications for the poorest in society in the UK and overseas from a 4+ degree world plus sky-rocketing fossil fuel prices would be immense, especially for the young and for future generations. It would dwarf the potential cost impacts from a transition to a low-carbon economy on current generations. The Stern Review for HM Treasury stated that the economic costs of inaction far outweigh the economic costs of action.

This research suggests that it should be theoretically possible to mitigate the most disproportionate impacts on vulnerable communities through well-designed policies and appropriate grants, benefits and tax breaks In practice the technical and policy changes identified within this report may be incredibly difficult to achieve. They would require a step-change in Government policy, significant technological innovation (including in negative emissions technologies), and may be strongly resisted by sections of the public (for example, expansion of on-shore wind, rationing of aviation or introduction of road-user charging)

There is a strong argument for broader Government policy to have a greater focus on reducing inequalities and poverty more generally, to help mitigate any unidentified or unavoidable regressive impacts resulting from some environmental policies. This approach is consistent with the broader sustainable development principles of meeting all people's needs within environmental limits.

The changes identified in this report require very rapid changes in every sector in the UK (and by implication in other developed countries and many fast-growing developing countries). These changes require significant levels of political and public will, which are currently lacking.

The main conclusion from this research is that the UK may, theoretically, with technical innovation and herculean efforts be just about able to make a transition to a low-carbon economy within the 'safe' global carbon limit used in this report. To do so requires very significant changes in every sector very quickly, and far faster than currently contemplated by politicians and the public. To do so without negative social justice impacts will required a determined effort to introduce policy pathways designed to reduce inequalities.

Given the scale and speed of change required, including behavioural change, some might say this level of change is not politically, economically or socially possible. This is not an unreasonable conclusion. If this is true then society with either need to accept a greater risk of dangerous climate change, with the social justice implication this brings, or consider much greater use of unproven negative emissions technologies. However, it would be wrong to bank on the ability of negative emissions technologies to significantly reduce mitigation efforts. These technologies will have their limits and may also be very expensive (this is the subject of future research by Friends of the Earth).

REFERENCES

1 Smith et al (2009), Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) "reasons for concern", PNAS 106: 4133, http://www.pnas.org/content/106/11/4133.abstract

2 Friends of the Earth (2010), Reckless Gamblers – How politicians' inaction is ramping up the risk of dangerous climate change. www.foe.co.uk/resource/report/reckless_gamblers.pdf

3 DECC 2050 Pathways Analysis at http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/2050/2050.aspx

4 Chakravarty et al (2009), Sharing global CO_2 emissions reductions amongst one billion high emitters, PNAS 106: 11884, http://www.pnas.org/content/early/2009/07/02/0905232106

5 AEA (2010) Report on options for decarbonising industry. http://www.theccc.org.uk/reports/fourth-carbon-budget/supporting-research/aea-report-a-peer-review

6 Cranfield University (2010), The effects of change in UK food consumption in land requirements and greenhouse gas emissions. http://downloads.theccc.org.uk.s3.amazonaws.com/4th%20Budget/fourthbudget_supporting_research_cranfield_dietsGHGLU_agriculture.pdf

7 United Nations Economic and Social Council (2011), Commission on population and development, 44th session, World Demographic Trends. http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N11/213/43/PDF/N1121343.pdf?OpenElement

8 Carbon Descent (2010), Pathways to 40 per cent. http://www.foe.co.uk/resource/briefings/job_creation_carbon_descent.pdf

9 Sustainable Development Commission (2010), The Future is Local. http://www.sd-commission.org.uk/presslist.php/112/the-future-is-local

10 Marmot Review Team (to be published May 2011), the health impact of cold homes, a report for Friends of the Earth, Marmot Review Team, Department of Epidemiology and Public Health, UCL.

11 Mott McDonald (2010),UK Electricity Generation Costs Update, http://www.decc.gov.uk/assets/decc/statistics/projections/71-uk-electricity-generation-costs-update-.pdf

12 http://www.businessgreen.com/bg/news/1804962/former-chief-scientist-lends-voice-peak-oil-warnings

JUST TRANSITION

The purpose of this research is to answer the question "Is a just transition to a low-carbon economy possible within safe global carbon limits?"

The research presented in this report identifies the changes that are necessary for the UK to live within its share of a global carbon budget that is consistent with a 70 per cent chance of avoiding global average temperature increases of 2 degrees above pre-industrial levels.

The UK's share of this budget is identified as 9 $GtCO_2e$ between 2010 and 2049. The research identifies policy options for achieving these changes and considers whether these can be made without a disproportionate impact on low-income communities.

Friends of the Earth is:

- the UK's most influential national environmental campaigning organisation
- the most extensive environmental grassroots network in the world, with around 2 million supporters across five continents, and more than 70 national organisations worldwide
- a unique network of campaigning local groups, working in more than 200 communities throughout England, Wales and Northern Ireland
- dependent on individuals for over 90 per cent of its income.

Friends of the Earth

Making life better for people by inspiring solutions to environmental problems

Friends of the Earth England, Wales and Northern Ireland
26-28 Underwood Street
London N1 7JQ
www.foe.co.uk
Tel: 020 7490 1555
Fax: 020 7490 0881

September 2011