Energy review 2010 response

1. Scope of model:
(a) Are there any low carbon technologies or processes or major demand-side options which are not currently included within the scope of the model but that you consider should be in future?

Inter-seasonal heat transfer technology - this is a technology which has been used to heat large buildings on a small scale in Scandinavia and Germany. Due to the drawbacks of most renewable heat technologies (see below) we need another alternative. A crude direct proportion calculation from the online database of heat capacity and collector area suggests in principle it could be sized to a domestic scale. A summary of how it works follows. Heat is collected over the summer months either be means of a pipe work system collecting heat from a conservatory or solar collectors on the roof or by passing air under the slates on the roof. This air is then passed through a heat exchanger in a tank and the heat is passed to water (there are chemical systems but water would be the simplest). The tank is extremely well insulated. The system is automated in a manner analogous to a SHW system with sensors measuring outside collector temperature and tank temperature so that it only heats ans doesn't cool. In winter the system runs in reverse in that heat is transferred out of the tank via another heat exchanger into a low temperature system. Advantages; low energy system using a lot less electricity than heat pumps the collecting pump could be solar powered (remember the pump works at low speed its got all summer). Technically fairly simple with components that last a long time – so a good energy return on energy invested. A number of variants on the systems can be imagined. Disadvantages; like all renewable heat systems relies on a low temperature heat system with a very well insulated building. Will require supplemental heat input (immersion heater) in case there is a bad summer or the user runs out of heat stored.

Local heating systems - involving a variety of RH technologies linked together so people share the heat output of these technologies, balancing out there variable output or supplies. This isn't a technology per se just a different way of using them. Advantages means shortages of sun/wood etc may be ironed out to a degree and costs after the system has been built would be low compared to the alternatives. Disadvantages as you state in the pathways analysis report.

Low temperature electric heating – in this and I've stayed in a house with type of system in, an immersion heater heats water in a hot water tank fitted with a heat exchanger. The heat is then passed around the house via a low temperature system, in this case underfloor heating. The system was supplemented by a wood-burning stove which also heated the water in the tank, but solar and other RH systems could be used. Advantages cheap to install and flexible, cheaper to run than heat pumps no need for 3 phase supply. Disadvantage requires a low temperature system which could be difficult or impossible to install and a very well insulated building.

Passiv house – the German passiv house people reckon a lot of the current UK housing stock could be retrofitted to make it passive. The only heating system would be a mechanical heat recovery system. While I don't know what percentage could be brought up to this standard and I wouldn't think my house is one of them, it is worth considering given a lack of easy alternatives. It might be possible for many properties to make the building partly passive i.e. reduce the number of heating days dramatically if not remove the need for them completely. Disadvantage very expensive at present, but looking at the issue through a peak oil (below) lens it looks attractive.

On the **demand** side you have made one glaring omission- peak oil and in this I include peak gas, uranium (whose supply peaked in the 1980's) and coal whose reserves have fallen very substantially (BP statistical energy review 2009 puts reserves at 122 years now and this overstates supply anyway). The cost assumptions given for oil in annex A are quite frankly laughable.   We can argue about when the oil peak will occur (I think we are at the top of the peak), but what would be incredible is to claim that it won't be before 2050, which is what you seem to do. The oil peak has a number of very major implications, one of which will be not only the price of oil rise dramatically, but also all other conventional fuels. Its very hard to predict the oil price at the dates given but I would guess at least $300/barrel and probably nearer $600 in 2030 assuming we at or near peak now. If this seems alarmist remember once the peak has occurred the trend is relentlessly downwards since production will fully never recover. As you correctly point out in the 2050 document there are some areas where there are no alternatives (namely flying), or where alternatives will take a long time to develop and will be more scarce (chemicals). It also has a whole series of other implications relating to shipping freight/food/tourism etc. The modelling in the calculator needs the options on the appropriate point on the demand side that gas/oil/coal are severely depleted. I would like to make one final comment on this, that is I do not believe in a "techno fix" for peak oil and climate change. These problems will demand significant lifestyle change and adaptation that I and many others believe the general public is almost completely unprepared for. I strongly recommend reading the "Carbon Diaries 2015" and follow up 2017 books by Saci Lloyd. My comments on technologies below must be seen in this light.

2. Scope of sectors:
(a) Does the range of alternative levels of ambition presented for each sector cover the full range of credible futures? If not, what evidence suggests that the range of scenarios should be broader than those presented?

I'd refer you to the bit on peak oil in the last question, it needs modelling in to all six scenarios, but other than that I think all six are OK although there individual criticisms I would make of some of them.

(b) Do the intermediate levels of ambition (levels 2 and 3) provided for each sector illustrate a useful set of choices, or should they be moved up or down?

For the most part I think they are fine there were some on the demand side where I disagreed with the choices particularly on renewable heat/transport in the calculator where although I am not anti the technology I have concerns about the practicalities with heat pumps/biomass heating which clearly you share. I'd like to model some other alternatives in as well. I'd also like in the model the idea of growing more woody biomass by turning over up to 75% of UK upland areas to growing trees for use in heating.

(c) The 2050 Pathways Calculator currently describes alternative directions of travel rather than different levels for some sectors where changes reflect a choice rather than a scale. Is this a suitable approach and clear to users?

Yes I think that's OK.

3. Input assumptions and methodologies:
(a) For each sector, are the input assumptions and the methodologies applied to those input assumptions reasonable?
I don't agree with use of nuclear power for a large variety of reasons but setting the only power source to nuclear in the calculator and setting its value to four gives a carbon output of 1g/kWh and the difficulty of building 50 nuclear power stations in less than 40 years at 38 . I have come across a wide variety of figures for carbon emissions in my time but this is one is quite frankly ludicrous. With renewables (which give a much higher carbon emissions in the calculator) for most once they are made and installed apart from (in some cases) annual maintenance after the carbon payback has taken place that is more or less it. This is not the case with nuclear, the refuelling takes place every 18 months and it is the mining/treatment/purification formation and transport of the fuel that uses so much carbon.

The construction would be anything but simple essentially we would need to build one and a quarter a year for 40 years. Since we have not managed to build one in the UK for over twenty years and given the problems in Finland and France, its a projected build rate that is not credible (even if there was the uranium).

On hydroelectricity you are underestimating the resource. The data in England and Wales mainly looks at weirs and also ignores larger and smaller resources than this. There are many watercourses never used for water power in the past that could be used in the future.

Biogas I take the point about competition for use in transport but given the problem I view with renewable heat I believe it should all be pumped onto the grid (at least no no new infrastructure is required).

On microgeneration I think level 4 can easily be achieved for wind by 2050. You are quite right to say that using larger turbines than say 6KWp capacity will raise the output. The energy return is 29 fold (Allen et al., 2009).

Again on PV the level 4 should be achieved by 2050 with ease. You only have to look at Germany this year when somewhere between 6-10GWp of installed capacity will be installed this year. The EPIA estimate is for an upper installed capacity of 1.2GWp by 2014 in the UK. Early indications are that this is on target to be achieved (providing the FIT is maintained).

I'd like to comment on some aspects of the scheme and technology. Germany gave higher tariff rates for the northern Lander, Scotland and the north of England would benefit from a small differential over the rest of the UK. The energy return on energy invested with mono or poly crystalline PV is OK, probably about 1:10 since the modules outlast their their guarantee by 15 years. However, thin film has a much better energy return 1:40 and above. There are also technologies that work cross spectrum meaning that on a cloudy day the output is roughly the same as in full sun. The use of these technologies should be encouraged as should their local manufacture. It is worth stating that the UK is the largest manufacturer of small wind turbines in the world.

(b) Are the bioenergy conversion routes used in the model accurate, or are there more efficient routes for converting raw biomass into fuels?

Yes, microbial fuel cells, these are 80-90% efficient and require only liquid waste a feedstock.

(c) Can the model's assumptions on wave resource be improved, for example regarding the length of wave farms, their distance from shore, the efficiency of devices, constraints from other ocean users, and other assumptions?
Not technically qualified to comment.
d) Can the model's assumptions on tidal stream resource be improved, for example regarding the method for assessing the resource at specific locations, and the scaling up of individual devices into an array?

Not technically qualified to comment.

(e) Is there any evidence that would help build an understanding of the potential impact of long term spatial development on transport demand, and how could this be accounted for in the model?

I'm not sure I understand the question, however our cities are increasingly set up for car use. This will have to change in the future with peak oil so the maximum effort we can make through the planning system now to change this would seem useful.

(f) Due to uncertainties in the evidence base on energy demand and associated emissions, the model currently sets out only one level of ambition for the future UK share of international shipping. Is there any evidence you could contribute to help build a greater understanding of the potential shipping trajectories?

After the oil peak globalisation is going to go into reverse. Whilst its impossible to be precise about what will happen to trade its seems very likely that life will become extremely localised, not immediately but that's the direction that we will go in. Only raw materials, goods and products that are essential and that cannot be provided locally in our country will be imported. Due to the land area difficulties in providing feedstock for alternatives to plastics material consumer goods will become rarer and more expensive, that alone will cut international trade.

(g) Could the relative roles of coal and gas out to 2050 vary from the assumptions shown in this work, and if so, how?

I expressed my belief that this the case above, both can substitute for oil to a degree for transport for example. Therefore the price of both will rise faster than inflation and both will deplete faster than is envisaged at the moment.

4. Common implications and uncertainties:
(a) The introduction to the report sets out some of the implications and uncertainties common to the illustrative pathways. Does this list cover the key commonalities? If not, please identify other common implications and uncertainties and provide evidence as to why these are key conclusions from the analysis.

The pathway uncertainties other than peak oil seem very comprehensive. I agree with the uncertainties on biogas viz. a viz. competition form other sectors but believe as stated above the priority should be to pump the gas onto the grid. The infrastructure exists and the renewable heat alternatives are not that great.

5. Impact of pathways:
(a) What criteria should be taken into account in understanding the impact and relative attractiveness of pathways?

Peak oil, for example many areas will have no option but to de-carbonise whether they want to or not. Your agriculture section does not take peak oil into account, only climate change. Whilst I agree reducing greenhouse gas emissions are vitally important the section covers producing bioenergy and reducing emissions by land use and animal husbandry practices. Alongside all this the analysis needs to consider how to run a tractor with gas/oil, how to grow food without pesticides, how we will manage to transport food without oil and most importantly how to make do without nitrate fertilizers which use 3% of the worlds gas supplies every year to produce.

6. Cost analysis:
(a) Can you suggest a methodology by which the wider cost implications of choosing one pathway over another could be accurately reflected, and any relevant findings from such an approach?

Not technically qualified to comment. However, I would add the following points. Many of the renewables are at an early stage of the learning curve, costs will fall considerably. Currently the prices I am being quoted for a PV installation here, are way above Germany at 3euro/watt installed. The second point is we will just have to get on with it we don't have any choice, besides we have caused the problem what moral right do we have for it to be cheap? I was intrigued to see despite what I see as a pro-nuclear bias, nuclear comes out as the pretty much most expensive generation in all cost scenarios beaten only by offshore wind. However, nuclear has no learning curve left and offshore wind does (particularly if we can get the turbines made here).

This last comment isn't really about costs but about jobs. As part of the FIT and RHI you could mandate that a certain percentage of content is UK made. Ontario has done this, it was fairly disastrous at first because the state had no manufacturing capacity in this area at all. However, it is now paying dividends with different manufacturers setting up there every month or so. We do have some manufacturers here but are short in some areas (such as inverters). Could we not announce that that in five years time a certain percentage must be UK sourced? I know this does not fit in with laissez faire "Washington consensus" economics, but why not? It would also dent criticism of the costs of all this if people could see jobs being created here.

Finally another appeal on costs. As I suggested in the original 2020 energy target consultation one way to cut costs is to allow self installation of micro-generation equipment. Whilst many installations are on roofs where the great majority of people would get a professional installer in others such as one I am getting quotes for are not at height and could easily be done by me. I do think though that the self installed systems should be checked and signed off by a MCS installer. This would bring micro-generation into line with the England and Wales wiring regulations and would surely drive down costs.

7. Future improvements to model:
(a) Do you have any further suggestions for refining the 2050 Pathways Calculator?
(b) Could the 2050 Pathways Calculator be improved to reflect the fact that the level of ambition for some sectors will depend on local preferences? Could the Pathways Calculator be improved such that the inherent degree of individual and local choice in a chosen pathway were clear?

Things I agree with in 2050 model assumptions;

De-carbonisation of transport using electricity since infrastructure for distribution exists and its scalable.

Agree with concerns about biomass uses an competition on page 36.

You don’t mention fusion, this is good, it will never work and are lukewarm about hydrogen as you point out the energy losses involved with its conversion make it a non-starter.

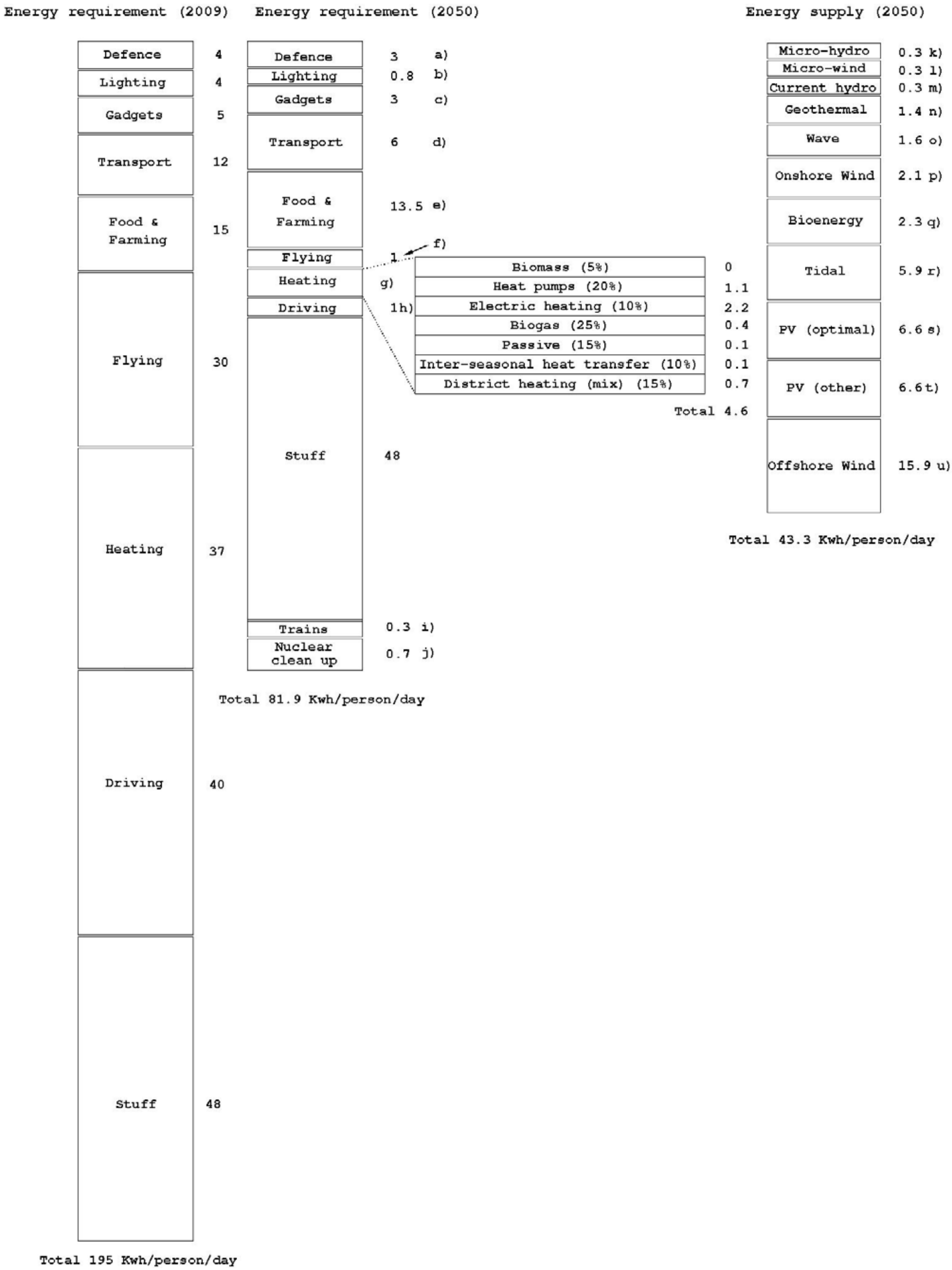
However, I have a number of concerns. Some of which have been outlined above about the apparent bias towards nuclear and to a certain extent wind.

I also agree with the concern expressed about PV’s and SHW on one roof. However, it is possible for them to share the same roof. I have $3.5m^2$ of SHW and $9m^2$ of PV on the same roof. You just need a rough average figure for the UK domestic roof area and subtract 3.5 from it as far as PV area is concerned. In addition this may not be so much of problem as PV module output/unit area is rising fast. Sharp have over the last couple of years gone 180W max to 235W and soon 300W all in the same size 1.65 x .994 modules.

One annoying feature of the calculator is that it insists on updating after each single change. It would be nice if the user could make multiple changes and then press an update button.

Taking David Mackays book "Sustainable energy without the hot air" and using his idea of taking the total energy used in the UK economy per person per day as a starting point I used the energy review calculator and other sources to see what I could come up with shown below. I liked this idea of his a lot although I disagreed with many of ideas in the book. For example the idea of extracting uranium from sea water is not only laughably impractical on the scale required but would never give a return on the energy invested.

Notes; general assumes for all practical purposes no gas/oil/uranium/coal in 2050. Midpoints between now and 2050 somewhere in between. Assume population of UK is 70 million.



a) Reasonable guess, military is somewhat smaller than today, a bit more energy efficient and at peace!? Any remaining oil is reserved for military use, or they use gas to liquids.

b) Assumes all lighting now LED's and probably less lighting use overall i.e. street lights and lights being left on in businesses overnight has ceased.

c) Gadgets - less of them since they are oil derived, however I've assumed only a 40% drop in energy use for them.

d) Transport guessed at 50% drop does not include trains for passenger transport. Don't quite know what to say about international shipping, in all likelihood there will be a lot less of this.

e) Assumes 10% of food is grown in back gardens/parks etc. All farming totally electrified, since maximum amount of food is grown in the UK I've only cut this by 10% to take into account the increased local production. Note no fertilizers or pesticides are available.

f) Cynically I reckon the super rich will always find a way to fly either using gas to liquids or the remaining oil, but the rest of us won't since the alternatives don't add up taking too much land area in competition with food.

g) Heating

15.5% passive

75% of new build from 2020 is "passive" making 15.5% (rounded down to 15% to make maths easier) by 2050 of total stock. This is not a technical issue but a regulatory one. Passive houses do need energy for the mechanical heat and recovery system. Assumed this is 100W for half the year. This is based on the assumption that most are domestic using between 20-40W/hour for this but a minority are commercial using a lot more, 100W is a round about estimate

Therefore energy demand is;

=15/100*42.9*1000000 = 6435000 (number of all buildings)

6435000 x 24 x 365/2 = 28185300000 (number of buildings x hours a year)

=100/1000/70000000/365 = 0.11 KW/day/person

The great majority of these buildings will be fitted with SHW but this has not been taken into account.

20% heat pumps

I have concerns about heat pumps, the effectiveness of them w/o supplemental heat and their electricity use and with ground source heat pumps the ease of installing the heat collectors. That is why they are 20% not higher.

energy demand (domestic)

Assume most if not all are fitted with SHW, my system has cut my gas demand by 6000KW/year but I have assumed a more modest 5000KWh/year cut. In addition all houses have better insulation cutting demand by a relatively modest 30%. Its a moot point whether particually air source pumps would keep a house with that level of insulation warm enough. Therefore starting heat demand is

=(20000-5000)*70/100=10500KWh/year total heat demand

= 10500 x 20/100 x 42.9 x 1000000/4/70000000/365 this figure is multiplied by % of houses and divided by 4 the COP value giving

= 0.8KWh/person/year

For commercial buildings done the same thing but multiplied current commercial heat demand 85? Twh/year from graph on page 105 by 2.7/1.8 (increase in commercial buildings) then by the percentage of commercial buildings and divided this by the COP value

85*1000*1000*1000/70000000/365*2.7/1.8*25/100/4 = 0.3KWh/day/person

Straight electric heating (10%)

Domestic demand

as for heat pumps except not /4

=(20000-5000)*70/100*10/100*42.9*1000000/1/70000000/365= 1.7 KWh/person/day

For commercial buildings done the same thing but multiplied current commercial heat demand 85? Twh/year from graph on page 105 by 2.7/1.8 then by the percentage of commercial buildings and divided this by the COP value

=85*1000*1000*1000/70000000/365*2.7/1.8*10/100= 0.5 KWh/person/day

Biogas (25%)

Calculations much as above assumed 7% of energy delivered is used to pump gas onto and around grid both domestic and commercial buildings are;

=(20000-
5000)*70/100*25/100*42.9*1000000/1/70000000/365*7/100+85*1000*1000*1000/70
000000/365*2.7/1.8*25/100*7/100 = 0.4 KWh/person/day

Biomass (5%)

Energy used included in farming/transport.

Inter-seasonal heat transfer (10%)

Taken as equal to passive.

Remainder

Assumed remainder is a mix of technologies above but in district heating and these technologies are largely inked together. This is I admit a kludge but I've taken an average of the energy demand above for the energy needed to deliver these mixed systems.

h) Driving

Assumes an average of 10000 miles per year for 20,000,000 cars with a 200 mile range per charge (assumes plausible increase in range) which is 24 KWh, so 50 charges per year.

Thus =24*10000/200*20000000/70000000/365 = 0.9 KWh/per day per person (rounded up to 1).

i) trains

All of the UK's train network is now electrified in addition 3 new high Speed lines have been built (East coast main line to Scotland, West coast main line to Scotland and London South Wales). Equivalent of quadrupling in journeys by train although some of this takes into account electrification.

Energy per passanger per km assumed to be that of TVG 0.15MJ convert this to KWh

=160000000000*150000*0.00000027778/70000000/365= 0.3 KWh/person/day

j) nuclear clean up

By 2050 clean up of the current nuclear power stations will be in full swing. This clean up and storage of waste will occur in a post oil world and the energy requirements must be accounted for. Since no nuclear plant has been completely cleared up or the waste dealt with the amount of energy required can only be guessed at. Jan Willem Storm van Leeuwen has made an guestimate of 80-163 pecajoules (this has been taken to be 160per 1GW reactor equivalent). Also the clean-up has been compressed to thirty years rather than 100 years due urgency caused by rising sea levels. The figure includes some energy for storage but not as far I can see the building of an underground waste repository.

=160 x 1x 10^{15} x 0.00000027778*12.5/30/70000000/365= 0.7KWh/person/day

NB. 12.5 is the number of 1GW reactor equivalents.

k) micro-hydro

Energy review 2010 level 4 which I believe to be an underestimate. TWh divided by population/days in year.

l) micro-wind

Energy review 2010 level 4 which I believe to be an underestimate.

m) existing hydroelectricity

Taken as 9TWh/year.

n) Geothermal

Energy review 2010 level 4.

o) Wave

Offshore evaluation report total practical resource.

p) Onshore wind

Energy review 2010 level 2 with some misgivings as to whether this is possible due to nimbyism and planning battles.

q) Bioenergy

Energy review 2010 level 1? Almost tempted to remove this regard it as implausible when we need to grow food.

r) Tidal

Offshore evaluation report total practical resource.

s) PV optimal

South facing Energy review 2010 level 4. Added 20% to this due to two new technologies both of which can overcome shading limitations (one is individual inverters on each module). These should raise output by 30% but I've put a more modest 20% in.

t) PV suboptimal

Set as equal to the optimal in the Energy review 2010 pathways suggests 320TWh/year could come from PV on non south facing facades. I've assumed just over half the potential output is tapped (on my own house south facing roof is tapped but I have suboptimal south facing conservatory shading) and flatish west facing roof). Again the shading issues can be overcome raising output.

u) Offshore wind

Offshore evaluation report total practical resource. Ignored floating wind turbines completely, this is as far as I am aware an untested technology, although if it works our problems are over.

Other

Balancing carried out using lots of technologies with the word "smart" in, also a DC north sea supergrid and increased pumped storage and small scale mechanical storage (compressed air/flywheels) Energy review 2010 level 4. No CCS/nuclear/fusion. Also assumes there is sufficient lithium/neodymium etc. worldwide to do the task required of these materials.

Conclusions

To my surprise electric cars and heating use manageable levels of electricity. We can provide for our needs using renewables with the exception of "stuff". If we largely remove this we can do it. It is highly probable peak oil will do this for us. Many of my assumptions are relativity modest.