UK HM Government

2050 Pathways Analysis

Call for Evidence – Atkins Response

Plan Design Enable

30th September 2010

Atkins applaud the efforts made by DECC in energising the public debate on the practical delivery of the 2050 targets and confirm that we will be very pleased to participate in future discussions.

We have submitted comments only where we consider that they will add value to the work being undertaken by DECC. Before submitting our responses to the questions raised by DECC we make two short comments:

a) Whilst we fully understand the reasoning for excluding the consideration of the potential or actual impact of the policy levers available to HMG, the consequence is that the scenarios could be considered as unrealistic. This means that the assumptions are, by necessity, very general and largely speculative. We recognise that the longevity of any policy levers cannot be guaranteed, but whilst they are in place they do have a physical impact.

b) It can only be the responsibility of HMG to facilitate the development of the 'infrastructure skeleton' that is required to deliver the Low Carbon Economy and this has an enormous impact on the delivery of a Low Carbon Economy. Whether this is in relation to the promotion of high speed rail links or the clustering of power plant with CCS these strategic planning matters can only be delivered (at the pace required) through the development of spatial strategy by Government.

Q1 - 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?

Transport: There seems to be no consideration of the possibility to better enforce or reduce speed limits on main roads (where current limits are 70 and 60 mph) as these measures could result in important reductions in emissions (as well as potential safety benefits) if implemented. This might be linked to the need to support assumptions with regard to GDP growth. Similarly, the introduction of pricing mechanisms (increase in fuel tax or per kilometre charge) is not identified as a potential lever for behaviour change. There are references to the need for "lock-in" policies to support the assumption that any rebound effects are mitigated but pricing mechanisms could do more than manage the rebound effect by also reducing travel demand. This could however conflict with assumptions on GDP growth.

Industry: We would like to see consideration of underground coal gasification + CCS. This will allow the exploitation of coal in the medium term and demonstrate the valuable contribution towards our own energy security.

Micro-generation: We note that micro-CHP is covered in Section D, but we are unclear as to whether the electricity generation from such equipment is incorporated in the model. Other than this, limiting micro-generation to small scale wind power and pv is appropriate.

Tidal range, Wave energy and Tidal stream: The demand side management options must be part of the mix – in search of the "negawatt". Please note that in the tidal range section it states that two way generation implies more expensive turbines and larger caissons. Atkins considers this to be untrue and unnecessarily downbeat. We are aware of a two way system that uses smaller caissons, low price turbines and rapid construction techniques.

Q2 - 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?

We agree.

(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?

Tidal range, Wave energy and Tidal stream: In general we agree since these levels of ambition are presented for comparative purposes any move up or down might be seen as a vested interest.

Micro-generation: For small scale wind, the trajectories appear unrealistic in the assumption of reaching saturation at around 2010. Our instinct is that the curves should be smoother. Other than that we feel that Levels 2 and 3 are reasonable. For photovoltaics, we feel that Level 2 and Level 3 are probably over optimistic despite the FIT subsidy. Much still depends on gaining capital cost reductions through mass production and the practicalities at individual sites – for example the load bearing ability of roofs, shading and access. We would also point out that in the practical world, cost effective energy efficiency measures should be undertaken prior to consideration of micro-generation as this generally will be a more effective use of capital in reducing carbon emissions.

Onshore Wind: There will be considerable competition for the internationally limited turbine manufacturing capacity. The lower on-shore installation costs will be significantly off-set by developers by the business risk associated with planning delays.

Offshore Wind: The challenges associated with the major infrastructure changes required to deploy all the equipment offshore must not be underestimated. It is unlikely that we will see wide scale deployment of larger turbines or alternative configurations (e.g. Vertical Axis) between now and 2020. However, designing and constructing for reliability and robustness is absolutely essential given the significant hazard, time and cost associated with repairing installed plant.

Of equal concern to turbine supply is the provision of turbine foundations. To install 30GW in UK waters in 10 years requires a build rate of 3GW per year, i.e. 600x 5MW turbines pa. BiFab, the leading supplier of jacket foundations in the country, is gearing up to produce up to 120 such foundations, only 20% of the annual requirement. It is unclear where the remainder will be sourced. Other fabricators, such as McNulty, Nigg, H&W will need to develop the capability to supply similar volumes.

The delivery of the electrical infrastructure to support the wind sector is fundamental. There is considerable industry uncertainty around the long term viability of the proposed offshore OFTO regime and there is concern that planning delays will prevent the onshore grid being strengthened as required.

Level 1- 'Baseline': Lacks ambition, and if this were ever published as a target or projected outcome it would strongly deter investors. The appetite and hunger in the market is clearly apparent for 20GW+ by 2020.

Level 2- 'Reasonable Expectation': This is a description of what UK industry is currently planning to achieve. It will require significant investment and ongoing optimisation of technology, but won't necessarily need any technological revolutions - i.e. if we get better and faster at doing what we are doing now, then this should be achievable

Level 3- 'High Ambition': This starts to move towards technology revolution - i.e. 10MW+ turbines will need to be standard, as will year round installation vessels. A significant increase in research and development funding in these areas will be required, and a level of central planning and funding will probably be required for the large scale vessels.

Level 4 - 'Extreme Challenge': As per Level 3, but double all the concerns - this would require installation vessels that are floating production platforms, impervious to sea state and potentially capable of installing multiple turbines at a time. The onshore grid connection and interconnector issue would be even more challenging to resolve, and might require large scale energy export.

(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?

In general we agree.

Transport: Transport sector analysis mostly presents scale changes rather than choices. The distinction seems logical.

Buildings: Atkins is not convinced that we can allow the stakeholders to make their own choices, sending us down a particular pathway. Government and its advisers must agree on 1 or 2 preferred pathways. Some would say these are already evident in government policy and the move to nuclear power. Otherwise self interest and commercial behaviours will prevail and not produce the carbon abatement we must achieve.

Nuclear power: Multiple reactors at all of the nominated sites may be challenging from a grid perspective – especially in regions such as Cumbria (three nominated sites in an area of poor grid connectivity). Additional sites or an alternative approach may therefore be needed for deployment above 15 to 20GW.

Nuclear power is not a particularly flexible technology from an operational or financial viewpoint. This may well limit the practical feasibility of the high ambition or extreme challenge scenarios, particularly in combination with intermittent or inflexible technologies such as wind.

Level 3- 'High Ambition': Reference is drawn from the build rate in the 1980s in France but this is quite a problematic analogy. France was seriously hurt by the oil shock and generation was within the government's ownership and hence they were able to directly control the rate of build. In addition, the French build rate was achieved at a time when there was no global new build programme in place. It is also noted that:

- The capital strength of power companies will be challenged by these build rates.
- The trajectory assumes world demand for power plants does not compromise the UK demand. This is likely to become a problem at these build rates.
- The availability of uranium, the capacity of enrichment plants, the availability of a waste route from the stations for this scenario are all ignored (or assumed not to have an impact). It is highly likely that the accelerated build rate from 2025 would drive us to a different reactor design, involving a fast breeder design so that more of the fuel can be reused again – reducing the pressure on the waste route and reducing the pressure on new ore and enrichment.
- The current electricity pricing mechanism is assumed to support this rate of growth. Introducing this level of permanently-on base load will challenge the current electricity pricing methodology and it is likely to not support nuclear – prices will gradually be forced down to marginal cost for base load and at this point nuclear firms all go bust.

Level 4 - 'Extreme Challenge': Similar points to Level 3 (fast breeder technology, world demand will prevent this growth rate both due to ore and enrichment demands and plant equipment demands).

The delivery of 146GW nuclear will probably require 120 new stations; at £5bn a station that's £600bn. The energy companies will not be able to take this level of capital onto their balance sheets nor will they have an appetite for the risk. It must be assumed at this level the UK government re-takes control of energy generation in the UK. An open market simply will not provide this level without an enormous profit margin that would leave the end consumer with an unbearable bill. Either the government must re-instate the CEGB (not credible) or an extreme price for carbon must be set. But an extreme carbon price may just push companies outside of the UK, energy companies are global.

The biggest risk to the Level 4 scenario is the assumption that a coherent transmission system can be achieved where this level of output can be balanced against the other energy sources on the grid. This is a complicated issue. If wind is part of the system it must always be favoured when the wind is blowing, but what does this mean for the nuclear fleet that cannot be turned off. Nuclear stations are inherently inflexible and the scenario creates two fundamental challenges:

- What to do with the surplus power? An electrified mass transit system which can provide or take power to the grid control by an advanced smart grid will be needed, along with a huge amount of pumped storage, possible hydrogen generation and probably gas stations moving to open cycle (instead of combined cycle) to allow them very high flexibility.
- How do you price electricity? Without a clear and guaranteed price companies will not invest. It will be almost impossible to have a market mechanism for this price, as at this level of output nuclear electricity will be priced at marginal cost (almost nothing for a nuclear station) and all operates will be bankrupt.

Q3 - Input assumptions and methodologies

(a) For each sector, are the input assumptions and the methodologies applied to those input assumptions reasonable?

Buildings: There needs to be more focus on avoidance of energy consumption by building fabric improvements. This prioritises reducing energy demand which is essential. Technology will not produce the real reductions required on its own. Design quality must also be addressed. Good design saves carbon and provides better internal environmental quality. This is design of the building envelopes as well as the systems inside them.

We must not promote technologies that lead to increased energy consumption across the year. Heat pumps can be too readily used for cooling in summer, increasing annual energy use and carbon emissions. Air based heating systems are energy intensive and typically do not give good internal conditions. The heating is very superficial and makes little use of thermal mass. Air based heating systems are seen less and less in well designed buildings. There are some sweeping generalisations made in support of heat pumps which are not properly compared with alternative or even traditional solutions. Atkins does not believe this is a fair assessment of all the technologies.

Atkins does not agree that residential buildings will require active cooling by 2050. Good design can mitigate temperatures adequately. It is the current stock of poor residential buildings which are suggesting this and these need to be changed along with people's expectations. Air conditioning is not a sign of wealth but more a sign of poor building quality.

Atkins does not agree with the arguments against district heating and we are disappointed it is so poorly represented in the scenarios. The use of waste heat is viable for a large portion of the UK population and is essentially carbon free. All thermal and nuclear power stations give off huge amounts of waste heat. The technology is simple and readily available. It has less impact to residential space and is reliable because of the network capacity. We must connect all thermal loads within acceptable distances of thermal plants before any other solutions. Perhaps the existing gas network can be changed over to hot water and supplemented with a return pipe as part of a future district heating network. It could be said that the gas utility is best placed to provide community heating services alongside a dwindling gas market.

The implications of an electrically driven infrastructure are understated. To replace thermal loads by electricity is a massive undertaking with significant implications for the UK.

The use of CoP to compare heating technologies is not a good measure of their impact. Carbon emission per kWh of energy produced for both heating and hot water are a more reliable factor.

Transport: To 2050, passenger kilometres per person per year grow in all four levels of domestic passenger demand (as shown in calculator spreadsheet, sheet XII.a, domestic passenger transport). There is an argument that the number of trips and the time spent travelling could remain broadly constant in future years (as they have remained since the 1970s). Where levels of ambition include significant mode shift from the individual car, this could result in people travelling shorter distance by other modes (public transport, walking and cycling) and should be reflected in the analysis for these levels.

Mode share assumptions (as shown in calculator spreadsheet, sheet XII.a) for the more ambitious levels of domestic passenger transport pathways could be seen as conservative, especially with regard to walking (no increase in km share) and rail versus domestic air travel (it is possible to argue that improvements in long distance rail journeys would displace some domestic air travel).

Trajectories 2, 3 and 4 on technology penetration for electric, pug-in hybrid and fuel-cell vehicles appear very ambitious and would rely on significant technology breakthroughs as well as changes in car ownership models. The assumption that different technologies could be used for different journey length would require car owners to be ready to change to car rental and car club type models to gain access to the right vehicles for the journey they are planning. These models might also be necessary to address the limit the technology risk for those who will be the first users of new technology.

All the studies we have looked at show little impact on biofuel carbon intensity relative to transport. The carbon factor appears to be driven by wood source and processing of it. There needs to be effort on better use of waste timber for fuel stocks. There seem to be a number of barriers to the use of waste wood, based on location of the waste, logistics and value.

Micro-generation: We would query whether the model takes account of competition for roof-space with solar thermal installations.

Bioenergy and Waste: For waste we would suggest that the methodologies used to determine the three trajectories are reconsidered and that an alternative method may be applicable based on the likely outcome of current and proposed long term procurement routes rather than relying on strategy objectives. In some cases this may be by assessment of the reference project in the Business Case for Waste Authorities, but for others a review of what is actually being proposed by preferred bidders.

The current methodology uses 2020 as a key year in meeting the existing waste strategy targets, which is reasonable, however we would argue that the infrastructure that will be put in place to deliver the 2020 targets will implement the Trajectory B scenarios faster. The majority of major waste management procurement exercises are looking to establish infrastructure by around 2014/2015 (if not earlier) which will not only meet the 2020 targets, but provide a greater energy focus beyond 2020. The majority of energy infrastructure proposed will have a contract term of 25 to 30 years plus possibly further extensions of life beyond this. This would mean that the infrastructure will be in place until at least 2045 if not 2050.

We feel that Trajectory A is possibly slightly pessimistic, particularly with regard to energy recovery and the amount of waste going to landfill and Trajectory B may better serve as a baseline. As described above, an alternative way of considering the methodology for this would be to evaluate those PPP and PFI procurement processes currently running or closed and look at contract end dates. There is also a large amount of merchant energy from waste capacity available in the planning system (or early build) which would also seem to imply a greater focus on energy over landfill and with banking requiring a minimum of 25 years of inputs.

In Trajectory A we would question why the emissions from landfill would increase past 2020 given the current engineering measures required for landfill containment and the strong focus on improved gas utilisation. Current emissions figures are skewed by the old (and in many cases closed) landfills with poor engineering and little ability to efficiently collect landfill gas for utilisation.

In Trajectory C the recycling rates appear over-ambitious and we believe that energy recovery will still have a larger part to play given the installed infrastructure.

The efficiency figure for gasification appears high for waste, however we acknowledge you have provided for best case figures in the model.

Atkins considers that more work is required on the imports of biomass, in particular with reference to life cycle analysis. The author acknowledges the difficulty is trying to predict a global biomass economy, however there are some lifecycle issues widely reported that would seem to bring the whole import issue into doubt. This can be evidenced by way of the approach of some planning authorities to large biomass energy plans in port locations and their view on carbon impacts of global biomass trade.

Tidal range, Wave energy and Tidal stream: Atkins considers that the estimates of energy available need more work not least because they assume one way generation only. This also impacts on the scale of grid connection as the peak output generated from such a system will cause significant grid connection issues and potential grid instability. The statement that the technology is similar to hydropower is correct only if an unsuitable one way turbine is used. Since tides are 2 –way the turbine design should reflect this.

Lifetime assessments seem sensible – although it is probable that sediment regimes, if large bodies of sediment are mobilised, could cause early erosion of turbine blades as has happened in some African and Pakistani hydropower systems.

Supply chain issues are sensible – there would be a need (under even level 1) for new drydocks, new fabrication facilities and the acquisition of large quantities of rock for concrete and revetment.

Level 4 seems to represent an unrealistically large deployment.

For wave energy/tidal stream the estimates of energy are sensible given the very vague level of understanding of how large farms of wave machines would interact. The location of the wave farms is reasonable from an energy capture perspective but the technologies available, or in development, to operate in such environments and the ability to export the energy produced to shore in a reliable fashion mean that the likelihood of these farms being developed in the timeframe offered is remote. For the tidal stream machines there is even more uncertainty and there is undoubtedly need for fundamental research and funding support to prepare a convincing business case.

As regards specific sectors:

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

The bioenergy conversion routes are generally accurate, however in the flow chart in Figure F1 we would argue that dry biomass could be converted into energy directly by traditional combustion and combined cycle generation without needing a biomass conversion process in order to create a liquid, solid or gaseous hydrocarbon for energy end use. This would include use of waste in co-fired traditional power stations that have been adapted for WID compliance as well as modern EfW. Some of the processes currently available for conversion of dry biomass to gas are less efficient than simply using the material in its raw form.

In addition, the cement manufacturing industry is becoming an increasingly important user of dry biomass derived from waste and the offsetting of other non-renewable fuel sources should be considered.

The imported biomass could be expanded to more than already refined fuels and be introduced into the model prior to the bioenergy conversion processes for use in co-fired power stations or traditional EfW (e.g. import of coconut husk to be combusted in a traditional moving grate EfW without a conversion process to produce a specific fuel for end use).

(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?

Undoubtedly they could be improved given the current level of guesstimation – the question is at what cost? It might be worth testing the sensitivity of the business case and the assumptions to potential improvement costs and the benefit that could be gained from such improvements.

(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?

Undoubtedly the assumptions could be improved but not at this juncture since the range of types of energy generators is very wide, each potentially designed for particular niches in the tidal environment – at this strategic level it seems appropriate to do only sensitivity testing of business case.

(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?

Some evidence of the long term impact of land use planning is emerging for example, in the last year:

- The Stockholm Environment Institute report published in August 2010: "Towards a Zero Carbon Vision for UK Transport", or
- the "Sustainability of Land Use and Transport In Outer Neighbourhoods" (SOLUTIONS) research.

In the model, the effects of planning could be accounted for through a reduction in the total amount of km travelled and additional mode shift to walking and cycling. In recent transport sector studies for the East of England region and metropolitan areas outside London, Atkins teams have used available evidence to support assumptions on changes in general travel characteristics for a targeted area to represent the impacts of development measures. For example, change can be represented by assuming that an area's travel patterns become more similar to those currently observed in area types with lower car dependency or lower travel distances. For instance development might lead to travel patterns in suburban areas changing to become more akin to those currently seen in central metropolitan areas.

(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?

It would be useful to be able to consider shipping emissions alongside UK domestic emissions for comparison (and scale) purposes.

Recent changes that could influence future shipping trajectories include the fact that during the recession most container lines slowed their ships from 25 knots to 18 - 19 knots and saved almost half their fuel. As the market seemed to be able to accept with the longer voyages, measures encouraging lower speeds could potentially be efficient (perhaps through fuel taxation although this could result in ships refuelling elsewhere if taxation is at EU level only for example).

Additionally, the volume of container shipping is growing fast and even bigger ships are planned. This will reduce the amount of energy used per box on the trunk voyage (for example Rotterdam to Singapore) but could potentially increase total energy use as such big ships will spawn more feeder services into the ports able to handle them.

UK exports have also de-materialised leading to the number of tons shipped inwards considerably outweighing the amount shipped outwards, increasing the under-utilisation of ships leaving UK ports and decreasing energy efficiency.

Q4 - 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.

This section seems appropriate.

Q5 - Impact of pathways

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

Transport: The model would benefit from a better representation of cost implications, perhaps by comparing pathway costs under different public and private investment scenarios. This might show that behaviour change interventions are actually more desirable as they are generally lower cost.

Buildings: The attractiveness of pathways varies depending on the audience. What is attractive to the politicians may not be attractive to the public or industry. Somehow we need to make it clear what are the desired pathways so we can explore the impacts and overcome them for all stakeholders. There is enough variability and flexibility within any one pathway let alone across a number of pathways. Suitable factors may include disruption, increased/decreased costs, security of supply, and consequential impacts of not doing something.

Q6 - 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?

Transport: The full wider cost implications of each transport pathway are potentially wide-ranging, including social, environmental and direct economic impacts. Social and environmental effects are largely driven by changes in the volume, speed and location of traffic and the composition of the fleet (affecting air quality and noise), along with changes in the level of accessibility and options provided by the transport system. Economic impacts are largely driven by impacts on travel time and reliability.

Existing government guidance (in particular the DfT's WebTAG) provides details on existing approaches to estimating and valuing the impacts of transport measures on society, including approaches to direct monetisation where available and applicable (for instance attributing monetary valuation to noise impacts of schemes).

The guidance also sets out an approach for valuing aggregate direct economic benefits in the short to medium term. However, additional analysis is required to acquire an understanding of the disaggregation of the economic impact by sector and location and likely impacts in the medium to long term. In the recent study for the East of England region the Atkins team supplemented WebTAG analysis on the impacts of proposed scenarios with sector specific analysis using the English input-output table (a representation of the flow of goods and services in the economy). The relative significance of transport costs to different economic sectors in the region were considered as the basis of an analysis of the likely short to medium term responses of different sectors to travel cost changes associated with carbon mitigation measures. The same study also drew together research evidence and details of the existing economic structure to consider potential medium to long term economic effects of proposed scenarios including spatial aggregation and agglomeration, changing spatial patterns of investment and the potential for related 'green business' opportunities.

Buildings: Cost is used inconsistently within the report. Some sections consider it and some don't. Cost is too difficult to predict with all this level of variability and uncertainty. Carbon reduction is a much better measure because clearly some items are more effective than others at mitigation of emissions. We need to map the best fit and provide financial incentives to promote the beneficial pathways. This will avoid cost being an issue and ensure good outcomes.

Cost is not a good enough reason to discount a particular technology. The markets are very flexible and can readily change to deliver the undeliverable. The real challenge is passion and energy to make a change.

Q7 - Future improvements to model

(a) Do you have any further suggestions for refining the 2050 Pathways Calculator?

In general Atkins considers that it would be of value if the scenarios included a timeline and a clear relationship to the Carbon Budgets.

Transport: In transport terms, the rebound effect can be significant and would need to be taken into account. For example, in recent analysis undertaken by Atkins teams for the metropolitan areas outside London, the low carbon vehicle intervention modelled (assuming that the proportion of electric vehicles and hybrids in fleet doubled from the levels in the CCC's Extended Ambition scenario in 2022 and that proportion of small vehicles increased by 25% at the expense of medium and large vehicles) would result in an increase of over 4% in vehicle kilometres by cars and vans in 2022 if no changes are made to fuel/electricity costs (based on CCC assumptions) or taxation.

(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?

Transport: This would be possible by introducing to the model differentiation by TEMPRO areas and area types (area types used in the DfT's National Transport Model to categorise each area of the country to distinguish between settlements according to their size). This would build in the ability to choose different pathways for different area types (e.g. metropolitan areas compared to small market towns). It would however make the tool much more complicated to use, especially if it was also to include the possibility of selecting local authorities (using administrative boundaries) within which various area types could be found.

Buildings: The calculator is very clumsy and the terminology of the buttons was not very good. It does not reflect well the report. It is essentially too simplistic to be of any use. It was also very difficult to see the changes and a baseline needs to be shown in the background.

Waste: Although the implication of local preferences is important, particularly in the waste sector where local policies or political decisions will affect the chosen solution (in some cases ruling out energy from waste solutions), I cannot see a method of building this into the model without overcomplicating it.

Document Issue

Client:	DECC
Project:	2050 Pathways Analysis
Title:	Response to the DECC Call for Evidence
Job No:	
Document Reference:	2050 Pathways Analysis CfE - Atkins Response

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JOB NUMBER:			DOCUMENT REF: 2050 Pathways Analysis CfE - Atkins Response			
0	Issue for Comment	Various	[redacted]	[redacted]	[redacted]	September 2010
		Originated	Checked	Reviewed	Authorised	Date
Revision	Purpose / Description	ATKINS				

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