

Environmental Information Regulations (EIR) Request
Received: 22nd July 2021 with clarification on 4th August 2021

Date 07 September 2021
Ref Sent by email from communications@theccc.org.uk

Your request:

Original request 22/7/21

Under the Freedom of Information Act, I am requesting copies of all correspondence/emails/notes of conversations between The Climate Change Committee and Element Energy regarding the development of the trajectories for residential heat decarbonisation to inform the sixth carbon budget.

This should include the remit/instructions given to Element Energy and any subsequent guidance/clarification requested and provided to them.

Clarification 4/8/21

What I am looking for is correspondence that directs/instructs/guides Element Energy in their work. This would include the initial mandate (the commercial/funding issue is not relevant for this purpose) but details of guidance given to Element during their work is. In particular, any parameters that they were asked to work within would be important.

CCC response:

This request has been treated under the Environmental Information Regulations 2004 (EIR). Please find correspondence between the Climate Change Committee and Element Energy that directs/instructs/guides Element Energy in their work in Annex A. Personal details have been redacted under reg. 13(5) of the Environmental Information Regulations 2004 (EIR).

Also included as separate documents are the following attachments which are referred to in the emails set out in Annex A:

- Annex B – Copy of NZ Assumptions log with amends [see p.3 in Annex A]
- Annex C – Copy of Technical potential 230520 - EE v3 [p.119]
- Annex D – Scenario guidance 050620 redacted [p.158]
- Annex E – BBSA Shading Costs for CCC [p.230]
- Annex F - Copy of DH trajectory for Element [p.255]
- Annex G - steering document for modelling v7' doc [p.300] [This document also includes redactions under exception 12(5)(e) of the EIR]
- Annex H - Copy of Heat Pump Association High Temperature [p.313]

Climate Change Committee

1 Victoria Street,
Westminster, London,
SW1H 0ET

www.theccc.org.uk

Tender documents:

- Annex I - 6CB res heat specification v8 final clean redacted
- Annex J - CCC_terms_conditions_contract_services 16.10.19
- Annex K - ITT Residential heat decarbonisation redacted

If you are dissatisfied with the handling of your request, you have the right to ask for an internal review. If you are not content with the outcome of the review, you may apply directly to the Information Commissioner for a decision. In keeping with our transparency policy, the information released to you will be published on www.theccc.org.uk. Please note that this publication will not include your personal data.

Kind regards,
Climate Change Committee

Annex A

From: [Name redacted]

Sent: 10 February 2020 09:25

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: FW: Meeting 1 6CB res buildings steering group

Attachments: Copy of NZ Assumptions log with amends - for Advisory group feedback(AutoRecovered).xlsx [see Annex B]

Hi all,

Some extremely helpful feedback from BEIS on assumptions attached, grateful if we could integrate into our assumptions review this week. Suggest we all review, identify which are the non-controversial updates and identify which we need to discuss further this week before agreeing. Suspect heat pump efficiencies is in the latter camp.

Many thanks,

[Name redacted]

From: [Name redacted] (Clean Growth) [mailto:[Email address redacted]@beis.gov.uk]

Sent: 10 February 2020 09:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk>;

Subject: RE: Meeting 1 6CB res buildings steering group

[Name redacted],

Following on from the steering group meeting last week see below and attached for some further detailed feedback on the modelling assumptions. I understand [Name redacted] has now provided Element with the Delta EE study on

appliance costs which is where we saw some of the larger differences in assumptions.

Efficiencies tab

* See attached from [Name redacted] who has commented on some of these. The main one to bring out is that fact that we assume the hydrogen boilers will have a lower efficiency than gas boilers – this is when considering efficiency in HHV, hydrogen will have different thermodynamic properties to NG

* [Name redacted] has also flagged a couple of points on HPs:

* Heat pump efficiencies – these are generally higher than ours and based on the MCS Heat Emitter Guide. Ours are based on the RHPP trials and I would say are therefore more robust. We assume however that the RHPP trials do not represent good performance so higher levels can be justified. Again, good reasons for pushing to get MMSP data.

* I would question their use of load factors and the difference between appliances. For example, why does AHSP have LF 16% and Hybrids 25%? I’m not sure what they are using the load factor for but if it sizing we have moved away from this and to a more realistic methodology that considers meeting heat load at design temperatures.

Application of additional costs tab

- Hot water tank is assumed to be already present in households using resistive electricity or storage heaters. We don’t think this is necessarily true, as most people would probably use point of use hot water.

- We are not sure about what they mean with Community heating system. If it’s heat networks, why do they assume that it has no wet heating system?

- They assume that the installation of a hot water tank is needed if you want to install a heat pump in households currently using oil boilers. NHM data shows that only 15% of oil boilers are combi boilers, which means that the rest should already have a hot water tank. Therefore, hot water tanks might not always be needed

Suitability matrices tab

- On thermal loss and how that impacts suitability, we assume that homes with a heat loss up to 100W/m² are suitable for a low temp ASHP (i.e. 45C) and above this that high temp ASHPs are suitable up to a heat loss of 150W/m². This was developed from Delta EE work on suitability of electric heating in OffGG rural dwellings<<https://www.gov.uk/government/publications/electric-heating-in-rural-off-gas-grid-dwellings-technical-feasibility>>

- We are not convinced that the same thermal loss suitability constraint should apply when you install direct electric appliances. We assume that you can always get to the required heat level, it would just significantly increase your electricity bill
- is there a reason to only consider shared ground loop GSHPs?
- A blanket 50% of heritage buildings for heat pumps is quite a coarse assumption. For example, GSHPs with little/no external equipment may have a higher suitability than ASHPs if a key restriction is placing the external unit.

Shout if you have any questions on any of these.

Thanks,

[Name redacted]

[Name redacted]

Head of Heat Strategy Analysis

Clean Heat & Industry Analysis

Tel: [Telephone number redacted] | Mobile: [Telephone number redacted]

[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>

1 Victoria Street, SW1H 0ET

www.gov.uk/beis<<http://www.gov.uk/beis>> |
twitter.com/beisgovuk<<https://twitter.com/beisgovuk>>

From: [Name redacted] <[Email address redacted]@theccc.org.uk> [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 30 January 2020 09:13

To: [Name redacted] <[Email address redacted]@theccc.org.uk> [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk> [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk> [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk> [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;

[Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>;
[Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>;
[Name redacted] <[Email address redacted]@ofgem.gov.uk<mailto:[Email address redacted]@ofgem.gov.uk>>; [Name redacted] <[Email address redacted]@es.catapult.org.uk<mailto:[Email address redacted]@es.catapult.org.uk>>; [Name redacted] <[Email address redacted]@citb.co.uk<mailto:[Email address redacted]@citb.co.uk>>;

Subject: RE: Meeting 1 6CB res buildings steering group

Dear all,

Many thanks for agreeing to be part of the steering group for the development of trajectories for residential heat decarbonisation for the sixth carbon budget. We are very much looking forward to seeing you at the first steering group meeting on Tuesday.

Element Energy have been appointed to undertake the work and have drawn together the attached agenda for the session.

Appreciate that you all have different expertise and some elements of the agenda will be of less interest to some of you than others. Nevertheless very grateful for your input on as many areas as you feel able to comment on.

Please note that there is also an item of pre-reading – the attached assumptions log. This is a replication of the assumptions used for our net zero analysis, with comments and colour coding included to flag where we currently intend to make updates. Cells which are marked dark purple indicate where updates are planned, cells which are marked light purple indicate potential areas for update. We would be very grateful for your review of the following tabs (note that the energy efficiency assumptions are being QA’d separately):

- Technology base costs
- Additional costs
- Efficiencies
- Application of additional costs
- Suitability matrices

In reviewing we would be grateful for thoughts on whether:

a. there are any assumptions that aren't yet marked for update which you would nonetheless query and

b. whether you have views on appropriate alternative assumptions for those cells already marked for update

Do of course let us know in the event of any questions and thank you again for your time – we really value your input.

Best wishes,

[Name redacted]

-----Original Appointment-----

From: [Name redacted]

Sent: 20 January 2020 17:40

To: [Name redacted]; [Name redacted]; SM-Defra-151BPRMeetingRoom_2 (CCC); [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted] (Clean Growth); [Name redacted] (Clean Growth); [Name redacted]; [Name redacted]; [Name redacted]

Subject: Meeting 1 6CB res buildings steering group

When: 04 February 2020 14:30-16:30 (UTC+00:00) Dublin, Edinburgh, Lisbon, London.

Where: Meeting room 2

This message has been sent using TLS 1.2

From: [Name redacted]

Sent: 31 March 2020 08:41

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: RE: Updated inputs

Hi [Name redacted],

Thanks very much for sharing – am I right in understanding this run relates to the people-led scenario and aligns with the assumptions agreed to date for that? If so, initial reactions from me (which you no doubt shared when looking) were:

- Deep energy efficiency

- o As before I will also need to see a breakdown of the EE measures in the summary outputs so that I can compare this to net zero and 5CB for each run

- o Can we add to the summary outputs a % reduction in energy demand which is associated with energy efficiency? The 25% reduction seen in net zero will be what we are comparing everything to and we would want to ensure that the people-led package delivered something higher than this, given it is meant to illustrate how targets can be met using high levels of energy efficiency.

- o Problematic then that we are seeing no deep packages and few medium packages deployed in this scenario – we’ll need to consider what things we might be able to do to address this which are consistent with the scenario narrative, grateful for thoughts.

- o Are we assuming the 15% uplift in savings from closure of the performance gap? If so I am likely to get back today on some updates here which are likely to reduce the uplift so work in the other direction.

- High temperature ASHPs

- o Interesting that these now seem to be preferable to low temp. I think we need to reverse the pattern here such that low temp are the dominant technology, with high temp only where needed – doing so aligns with feedback from stakeholders and Committee champions on the need to prioritise high efficiency technologies to manage electricity demand and peak.

- o Is this something we would need to action through a technology constraint on high temp ASHPs? I wonder if adjusting this might also drive the uptake of deeper energy efficiency?

- GSHP vs. ASHPs

- o I see we now have a roughly even split. Do we know what parameters the model is most sensitive to here? I know we set some of our GSHP assumptions more on the optimistic side to see what the impacts were in relative uptake, so we may now need to rebalance so that we are being equally optimistic in assumptions for both.

- Inflexible/flexible/highly flexible homes

o I can't see inflexible homes meaningfully represented in the technology mix, even though we know more than half of homes should have this characteristic?

o Are all of the homes with SH storage the ones getting the highly flexible price?

- Communal ASHPs

o Did Mitsubishi respond on assumptions here, and do the assumptions in the model reflect this?

Helpful to also liaise over what order of scenario runs you are planning today. As discussed we need to find a way to establish the energy efficiency consistent with govt policy early on so that we can make sure runs reflect it. Good to also understand if you suggest focusing the refinements scenario by scenario, or to be doing runs of the 3 scenarios in parallel?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 30 March 2020 22:48

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Updated inputs

Hi [Name redacted],

I have uploaded the scenario outputs at the following link:

<https://we.tl/t-3UX35Pgp1H>

This contains the detailed outputs at archetype level, as well as summary of stock, emission savings and cost effectiveness at the aggregated heating system

and constraint attribute level. We are continuing with the QA of these outputs and have identified a few issues that will be corrected in an updated run tomorrow. Also, with the latest runs of detailed archetype and expanded list of technologies, we found that the size of live calculations for the full stock runs into several millions of rows, leading to memory error. To avoid this, we have initially run with all heating technologies to identify their cost effectiveness across the stock and filtered them to the ~ 12 most cost effective technologies (which are the most cost effective technologies for more than 99% of archetypes). Subsequent scenario runs have been run with this reduced set, which reduces the number of live calculation rows to around 1m and the size of saved output files to 1GB. The process of this filtering step is dynamic and can be repeated for other scenarios with different input assumptions on cost or efficiency.

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 30 March 2020 19:26

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: Updated inputs

Dear all,

Please find attached a number of updated documents/spreadsheets:

- An updated set of energy prices and carbon intensities
- these should now have the missing components discussed previously
- note for electricity and hydrogen, fine to aggregate non co2 emissions rather than splitting out by gas
- indirect emissions for bio should not be counted in sectoral analysis so have been excluded here
- An updated template
- Most of the changes are in the output sheets which are automated
- Cost calculation example
- Update to fix error in the cost calculations – the NPV formula for social discounting was doing so to the wrong year – although this didn't have an impact on the final £/tCO2 values.
- Central assumptions spreadsheet
- Contains updated OBR and ONS economic estimates on ‘historic GDP deflator’ tab – please use these for converting price years

Great if someone might be able to provide an update early tomorrow on when you are expecting to be able to send through runs for me to review (fine for early ones to be without the above updates if needed).

Thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]
Sent: 31 March 2020 19:59
To: [Name redacted]; [Name redacted]; [Name redacted]
Cc: [Name redacted]
Subject: Performance gap uplifts

Hi all,

Having spoken to [Name redacted], the view is that it would be best to try applying a performance gap uplift in the scenarios, using the 5CB in use factors as a basis.

I've attached my thoughts on an approach. Essentially the idea is to base the uplifts around the second column on slide 6 (note not 'total IUF'), with closure of a third of that in use factor in the people-led and govt-led scenarios, and half of the in use factor in high innovation.

The idea is to then see what overall average uplift this is associated with for each package – my estimate is that it would be in the ball park of the 8% and 12-14% savings that [Name redacted] suggests in the attached email, but grateful if you could verify after applying.

Hope that makes sense but happy to discuss if not or if you anticipate any challenges with applying in this way.

Thanks very much,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 02 April 2020 19:37

To: '[Name redacted]'

Cc: '[Name redacted]'; '[Name redacted]'

Subject: RE: Updated scenario outputs

Thanks very much [Name redacted], great to see these coming through and well done for getting through the QA issues.

I'm still a bit unclear on the extent to which the scenarios reflect the full set of instructions for each scenario in the relevant docs shared and the agreed assumptions updates? Some more specific observations/requests:

- Govt-led

- o Govt-led is meant to be high hydrogen where full hydrogen boilers are allowed, can we make sure this is reflected in the next run? Presume it hasn't been in this one?

- o Presume also that it hasn't been run with the high hydrogen price first to determine the level of energy efficiency?

- Hybrids

- o Thinking ahead to the innovation-led and central scenario, we will need to consider how to represent a world where there are a large number of hybrids and whether there are input assumptions we can reasonably vary without needing to force in.

o Can you confirm how you were applying peak and off peak prices to technologies in the previous modelling?

- Heat pumps

o Keen to understand the impact the load factor size has had. How big is the average heat pump now? I think for NZ it was 8kW.

- Energy efficiency

o Essentially the steer is that we want to have at least as much energy efficiency as we had for net zero (accepting some variance between scenarios)

o Can we try running with the old load factors and see how much more energy efficiency uptake it drives?

o Are you optimising for 2030 to get the energy efficiency levels? How many SAP C homes are the current energy efficiency levels delivering?

o Have we included the additional measures for fuel poverty? In one of the scenario docs I believe I requested that they be implemented as high packages.

- GSHPs

o Great we are seeing a healthy representation. Are you able to identify the key factors which have led to GSHP deployment increasing? I think the assumption at most risk of being optimistic is the lifetime of the GSHP groundworks (alongside suitability perhaps) so good to understand whether this or other assumptions are having the most impact.

- Storage heating

o Do we know why storage heating has dropped off? Are the homes that were getting this now getting high temperature heat pumps? If so can we please turn off high temp heat pumps as a technology in the govt-led and people-led and have them as a technology in high innovation instead to see what that does?

- Communal configuration

o Does the communal configuration now reflect the central supply plus individual heat pumps in homes?

In terms of the information to put in the summary sheet for each run, can we add:

- Titles so that it is easier to quickly see what the numbers relate to? Relevant on both tabs but also worth being aware I am getting reference errors in the titles on the cost effectiveness sheet

- The number of cavity walls, solid walls, lofts and floors insulated in each scenario?

- The % reduction in heat demand as a result of energy efficiency
- I am keen to know what % of the stock is coming above £500/t, who they are and what the residual emissions associated with them are
- Thanks yes as per the below, grateful for an updated version of the table below in each template:

	Counterfactual total costs	Net heating system capex (inc household conversion)	Net EE capex	Net fuel and maintenance costs (excluding savings from energy efficiency)	Savings from energy efficiency	Total net costs
Net zero: Residential	23,103	8,816	6,114	1,760	-£13,304	3,385.90

Thanks very much,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 02 April 2020 16:57

To: [Name redacted] &[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk>; [Name redacted] &[Email address redacted]@element-energy.co.uk>

Subject: Updated scenario outputs

Hi [Name redacted],

I have attached the summary outputs for the government and people led scenarios. This now includes the following outputs:

1. Breakdown of stock weighted average costs and cost effectiveness for all technologies (without any energy efficiency)
2. Scenario uptake, emission savings and cost effectiveness for the 15 shortlisted technologies

Some of the key insights from these scenario outputs are:

1. HP being much more cost effective than H2 Hybrids or H2 boiler due to the lower electricity cost (7-11 p/kWh) and higher H2 cost (8p/kWh) compared to HTD

2. Lower uptake of EE during to improved cost effectiveness of HP, resulting from lower fuel costs and higher load factors compared to HTD

I will also include the full cost breakdown of the scenario outputs relative to counterfactual in the next version of output template.

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 07 April 2020 13:57

To: '[Name redacted]'

Cc: '[Name redacted]'; '[Name redacted]'

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Thanks [Name redacted]. That sounds right on the glazing.

I don't think we are aligned on the performance gap uplift from the description below unfortunately. You suggest that in the scenarios it is a half or third closure of the total IUF. That is not correct, it should be a third or half closure of the IUF, i.e. the left hand column below.

For the EPC calculation it should be full closure of the total IUF, i.e. the right hand column above. If you aren't following the logic of this, a quick call would probably be easiest as helping you understand my thinking is the best way to avoid QA issues further down the line.

As with the question I raised the other day I am not following the scale of uplifts suggested in your second and thirds tables below but I wonder if it is because of the above issue?

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 April 2020 12:03

To: [Name redacted] &[Email address redacted]@theccc.org.uk&

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

The previous numbers you saw were accounting for total demand (instead of just SH demand). This has now been corrected and applied based on the SH:HW demand ratio (accounted for by property type and property size), resulting in an average 23% increase in savings (i.e. average 1.23 factor multiplied by the previous % savings). Please see the updated table below with the new current savings:

Measure Current Savings Previous Savings

Roof 7.46% 6.41%

Glazing 3.62% 12.00%

Floor 9.31% 8.79%

Doors 2.16% 2.00%

Replacement Door 8.00%

Draught proofing 3.40%

Reduced infiltration 2.49%

HW tank insulation 4.19%

Cavity wall 11.13%

Solid Wall 14.99%

Wall 13.24% 12.20%

Roof+Glazing+Floor+

Doors+Wall 35.80% 41.40%

Additionally, the glazing numbers are still low because they are averaged with the uplift from band E. Along the lines of your suggestion, I have changed the packages to allot for glazing from band G; (Single glazed) to be in both the medium and high packages. However, I have set the glazing from band E; (Double glazed pre 2002) to only be accounted for in the high package. This way, the medium package should now be more cost effective. Please see the updated package savings below:

People-led / Govt-led / Central High innovation / Max

Package Weighted Average Savings Weighted Average Savings, including performance gap uplift

Low 11.97% 15.21% 16.83%

Medium 17.79% 22.31% 24.57%

High 29.13% 36.31% 39.91%

Finally, regarding the clarification on IUF uplifts, I believe we are aligned. For the scenarios, we are only using a partial uplift (of the total IUF factor; i.e. 1/3 or 1/2 depending on the scenario). However, for the EPC calculation, we are using the SAP uplift which is a full closure (of the total IUF factor). Please see the example below of a ETT cavity wall insulation being applied to a medium-sized, semi-detached dwelling in the Govt-led scenario:

UCL savings (based on gas consumption) UCL savings (after accounting for SH only) Model Savings SAP Savings

Percent 8.9% 11.0% 14.6% 22.0%

Factor applied from previous number - 1.23 1.33 1.50

The SAP savings of 22%, when compared to the UCL savings after accounting for SH, is double (or a 200% increment). This is in-line with a full performance gap closure based on the total IUF of 50% for CWI (i.e. $11\% * 1/(1-50\%)$). The model savings (in this case the Govt-led scenario) is a partial closure (1/3) of that full performance gap.

I hope that is all clear. Please let me know if you have any further questions. Hopefully we should see increased savings and uptake of energy efficiency measures in the upcoming runs.

Cheers,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 07 April 2020 08:49

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Thanks for doing the comparison, really helpful. I am confused about why glazing savings are so low, in [Name redacted]'s spreadsheet they are in the 4-7% range for an upgrade from band G? We would expect this % to be even

higher once set against the baseline for space heat demand only which I understand you are doing in the application process?

If we think glazing is at risk of making packages not cost effective, we could consider removing upgrades from band E windows and focus on band G only? Equally we could try removing the door from the packages if we think that would help?

To clarify, we should not be using total IUF uplifts for determining the actual energy savings in any of the scenarios – we should only be using the partial uplift of the IUFs discussed. This is because for scenario savings we are trying to uplift from real world savings now, to what might be achievable.

For the EPC calculation in both the policy and scenario runs, SAP works on the basis of modelled savings. This means that we should be using the total IUF (accounting for any uplift already incorporated) for the EPC calculation only. Hopefully that clarifies your question too [Name redacted]?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 06 April 2020 20:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Looking further into the Energy Efficiency (EE) cost and savings discrepancies from our prior work, please see the table below which compares (on a like-for-like measure basis) the savings and costs for the current and previous models (weighted averages using the savings and stock in each archetype where applicable). The general trend is that our current work accounts for lower savings yet higher costs. The trends we discussed this morning are likely (in-part) due to this.

The biggest difference is the glazing savings and the option of a replacement door in the previous work (deep package), where we only offer door insulation. As such, the total % savings in the packages is lower with higher costs.

Measure	Current Savings	Previous Savings	Current Costs	Old Cost
Roof	6.04%	6.41%	£ 1,296	£ 787
Glazing	2.92%	12.00%	£ 5,707	£ 5,456
Floor	7.61%	8.79%	£ 3,955	£ 3,946
Doors	1.74%	2.00%	£ 1,763	£ 349
Replacement Door		8.00%		£ 3,038
Draught proofing		2.76%		£ 192
Reduced infiltration		2.01%		£ 48
HW tank insulation		3.35%		£ 90
Cavity wall	8.99%		£ 3,997	
Solid Wall	12.12%		£ 6,645	
Wall	10.70%	12.20%	£ 5,443	£ 5,082
Roof+Glazing+Floor+				
Doors+Wall	29.01%	41.40%		
			£18,165	
				£15,621

However, now that we have moved from using in-use IUFs to the total IUFs, we should ideally see an increase in EE savings in the future runs (see attached performance gap uplift file). The savings we should see in each package are summarised below:

People-led / Govt-led / Central High innovation / Max

Package Weighted Average Savings Weighted Average Savings, including performance gap uplift

Low 9.65% 12.26% 13.56%

Medium 15.61% 19.57% 21.56%

High 23.57% 29.39% 32.29%

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk <[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0)>

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Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]

Sent: 07 April 2020 19:29

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Thanks [Name redacted], responses below

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 April 2020 19:02

To: [Name redacted] &[Email address redacted]@theccc.org.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&

Cc: [Name redacted] &[Email address redacted]@theccc.org.uk&

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Thanks for your notes and the updates. We have been updating what we could test. However, based on your latest email, the notes below in bold apply.

Regarding the upcoming scenario runs, we have updated the inputs to reflect the changes we propose testing. Please see the cover sheet in the attached (for today's entries) for the items that have changed. This includes the following:

- * All scenarios

- * HP and hybrid load factors updated (to test the old ones).

- * We can keep the lower higher load factors in the innovation scenario.

Sounds good

- * H2 boiler efficiency updated (to test moving to 87% to match gas boilers; will not affect People led).

- * We can revert to the 80% if you feel strongly that we should not account for this. If you want to include the 97% in this run no problem with that, given that we don't yet have a fully defined approach for forcing in. We can at least see the impact.

- * Including the technologies that can go in space constrained homes even if not in top 10 ranking.

- * [Name redacted] is looking into the latest run of all technologies with the EE package set to 'none' to identify the top 10-15

technologies and the addition of 2-3 electric resistive and storage for the space constrained and listed archetypes. This can then be used in the next set of scenario runs. great

- * Energy efficiency cost/savings updated.
- * Updated performance gap uplifts.
- * Removal of double glazing (from band E) from the medium scenario (only in high scenario).
 - * Double glazing (from band G) is still in the medium scenario.
- * Space constraints on high T HPs updated (unsuitable in SC homes).
- * Govt-led only
 - * Use low H2 price by removing H2 storage cost for the model run (so uptake will be higher).
 - * Currently doing so for the Govt-led; we can change this to only in the innovation scenario. Great, thanks

[Name redacted] will get back to you separately on the updates regarding the level of energy efficiency uptake and the latest policy run.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 07 April 2020 18:05

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

[Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>
address redacted]@theccc.org.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi all,

I'm just dropping you a brief email on the outputs of my chat just now but will hopefully be able to share some more comprehensive thoughts later:

- Load factors

- o We do want to see what the impact is of changing the load factors back to the old assumptions, we can then use the findings to decide how to apply. We would definitely be using the smaller sizing (i.e. the new load factors) in the innovation scenario though I think.

- Energy efficiency

- o We definitely want all fuel poor homes to be getting high packages (and the number of FP homes should replace the 3.25 additional measures we were forcing in previously).

- o Keen to see what the policy run implies for SAP C uptake and whether that is a route for getting more EE.

- o Mike (our chief economist's) view is that beyond this, we may wish to have lower EE in some of our scenarios if that is what the numbers are telling us. His steer is that we'd still want 25% in at least one scenario. I think in the other scenarios we should be increasing the level of EE where doing so results from sensible assumption adjustments (e.g. altering the technology mixes in the packages etc).

- Hydrogen

- o On hydrogen, Mike is more comfortable with forcing in hydrogen along the lines of the approach we discussed, rather than fiddling with assumptions to try to get uptake. I think that means we do use the hydrogen with storage costs.

- o However, can we try running the innovation scenario with the lower bound hydrogen costs to see whether that drives the hybrid uptake we are looking to represent?

- o If forcing in I don't think we need to worry about changing the H2 boiler efficiency in the run at this stage (and it looks like it makes a limited difference)

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 April 2020 16:09

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted]

Thanks for the suggestion. That indeed would be an alternative to <forcing> hydrogen in. The fuel price data is useful to see <the storage costs account for essentially the whole difference from the HTD/Net Zero study by 2050 (we knew that was the main difference but I wasn't sure if something else had changed too, as in the earlier years there is now a mix of H2 production technologies too)>.

We are working through the analysis of the Storage heating issue, and will come back to you with a proposed set of updated inputs for the next Scenario runs.

I hope your internal meeting goes well.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk> <[Email address redacted]@theccc.org.uk>;

Sent: 07 April 2020 15:20

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Thanks [Name redacted].

I've also been continuing discussions on alterations we might make and there is a suggestion from central team that we could use hydrogen prices excluding storage costs to determine measure uptake for govt led, but then hydrogen prices including storage costs to determine the costs associated with that measure uptake. I have attached an updated prices workbook where I have added in low hydrogen costs in rows 387 and below for that purpose.

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 07 April 2020 12:03

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted]

Thanks for the heads up, we have just had an internal discussion on this and anticipate the following order in terms of new insights/scenario runs:

1. Off-model; analysis of impact of factors on the HP versus H2 balance; within the next ~1 hour

* We are currently producing a comparison in cost and £/t terms of the various technologies under variations in:

- i. Load factors
- ii. H2 boiler efficiency
- iii. Level of energy efficiency uptake
- iv. All of the above combined

* This will give a indication of how close the Hybrid+H2 and H2 boiler technologies can get to competing with the HPs if we updated the above factors, or if we are still likely to need to force in; or make other updates; so hopefully in itself useful for your discussion at 4pm

1. Updated Policy run with constraints relaxed to £5000+4% of property value (excluding heating system) and £200/t, and with the updated IUF application; within the next 1-2 hours

* This is also underway and will be ready shortly

2. Updated Scenarios runs with the changes to input assumptions made; this afternoon, may be after 4pm as we need to agree updates, including any to address the low uptake of storage heating

* We can then re-run the Scenarios using the updated assumptions as above in point (1)

* We can also consider updates to address the Storage heaters uptake. We have done some initial analysis of this and have identified that:

i. This is as suspected partly to do with High T HPs being allowed in space-constrained homes; an error, we need to correct this

ii. Even then, low uptake of Storage heaters may persist due to the fact that Resistive heating is now lower cost or similar cost to storage heating, certainly in the Flexible case and even in the Inflexible case in many homes, due to the lower electricity costs again. In the partial; space constrained homes, the Communal systems and GSHPs are also lower cost than Storage heaters. We will need to explore this further once the High T correction has been made.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 07 April 2020 10:14

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi all,

Just to let you know timings, I have a chat with our Chief Economist at 4 today to talk about scenario end points amongst other things. Ideally I would be keen to have a view on what movement we could get through reasonable assumptions changes vs where we might have to force in – do you think you will be in a position to provide my more insight from your runs on the range of points ahead of this meeting?

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 07 April 2020 08:49

To: '[Name redacted]' <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Thanks for doing the comparison, really helpful. I am confused about why glazing savings are so low, in [Name redacted]'s spreadsheet they are in the 4-7% range for an upgrade from band G? We would expect this % to be even higher once set against the baseline for space heat demand only which I understand you are doing in the application process?

If we think glazing is at risk of making packages not cost effective, we could consider removing upgrades from band E windows and focus on band G only? Equally we could try removing the door from the packages if we think that would help?

To clarify, we should not be using total IUF uplifts for determining the actual energy savings in any of the scenarios & we should only be using the partial uplift of the IUFs discussed. This is because for scenario savings we are trying to uplift from real world savings now, to what might be achievable.

For the EPC calculation in both the policy and scenario runs, SAP works on the basis of modelled savings. This means that we should be using the total IUF (accounting for any uplift already incorporated) for the EPC calculation only. Hopefully that clarifies your question too [Name redacted]?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 06 April 2020 20:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Looking further into the Energy Efficiency (EE) cost and savings discrepancies from our prior work, please see the table below which compares (on a like-for-like measure basis) the savings and costs for the current and previous models (weighted averages using the savings and stock in each archetype where applicable). The general trend is that our current work accounts for lower savings yet higher costs. The trends we discussed this morning are likely (in-part) due to this.

The biggest difference is the glazing savings and the option of a replacement door in the previous work (deep package), where we only offer door insulation. As such, the total % savings in the packages is lower with higher costs.

Measure	Current Savings	Previous Savings	Current Costs	Old Cost
---------	-----------------	------------------	---------------	----------

Roof	6.04%	6.41%	£ 1,296	£ 787
------	-------	-------	---------	-------

Glazing	2.92%	12.00%	£ 5,707	£ 5,456
---------	-------	--------	---------	---------

Floor	7.61%	8.79%	£ 3,955	£ 3,946
-------	-------	-------	---------	---------

Doors	1.74%	2.00%	£ 1,763	£ 349
-------	-------	-------	---------	-------

Replacement Door		8.00%	£ 3,038	
------------------	--	-------	---------	--

Draught proofing		2.76%	£ 192	
------------------	--	-------	-------	--

Reduced infiltration		2.01%	£ 48	
----------------------	--	-------	------	--

HW tank insulation 3.35% £ 90

Cavity wall 8.99% £ 3,997

Solid Wall 12.12% £ 6,645

Wall 10.70% 12.20% £ 5,443 £ 5,082

Roof+Glazing+Floor+

Doors+Wall 29.01% 41.40%

£18,165

£15,621

However, now that we have moved from using in-use IUFs to the total IUFs, we should ideally see an increase in EE savings in the future runs (see attached performance gap uplift file). The savings we should see in each package are summarised below:

People-led / Govt-led / Central High innovation / Max

Package Weighted Average Savings Weighted Average Savings, including performance gap uplift

Low 9.65% 12.26% 13.56%

Medium 15.61% 19.57% 21.56%

High 23.57% 29.39% 32.29%

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk
[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name\]](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name])

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uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4
cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkh
JuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0>

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From: [Name redacted]

Sent: 08 April 2020 10:21

To: '[Name redacted]'

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

It took me a while but I think the below looks correct in light of the below excerpt
from the study about how IUFs should be applied. Grateful if you could make
sure these calculations are on the QA list though.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-
energy.co.uk]

Sent: 07 April 2020 15:02

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

As just discussed over the phone, I think we should now be aligned.

We have reverted to the 'In-use' column values for the scenarios and kept the 'Total IUF' values for full closure in the SAP uplift. The final estimations of package uplift are now more in-line with your prior calculations. This is summarised and updated in the attached. For the purpose of clarity, I've also included the table below which shows a step-by-step calculation of how we determine the scenario uplift factor and SAP uplift factor that are being used in the model.

Variable	Value	Formula	Explanation
Cavity Wall In-use	35%		Value from table (left-most column)
Cavity Wall Total IUF	50%		Value from table (right-most column)
Scenario Closure	33%	$= 1/3$	Chosen 1/3 closure for modelling
Scenario Uplift factor	117.95%	$= (1 - 35\% + (35\% * 33\%)) / (1 - 35\%)$	Based on closing the 35% closure by 33% (used in the model by incrementing/multiplying by the UCL-corrected CWI savings value)
SAP Uplift factor	169.57%	$= 1 / (1 - 50\%) / 117.95\%$	Factor relative to the scenario uplift (used in the model by taking this value and multiplying by the scenario uplift factor to get the SAP equivalent total uplift factor)
SAP Equivalent total uplift factor	200.00%	$= 169.57\% * 117.95\%$	Based on closing the 50% closure by 100% (equivalent factor, not relative to the scenario uplift)

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 07 April 2020 13:57

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Thanks [Name redacted]. That sounds right on the glazing.

I don't think we are aligned on the performance gap uplift from the description below unfortunately. You suggest that in the scenarios it is a half or third closure of the total IUF. That is not correct, it should be a third or half closure of the IUF, i.e. the left hand column below.

For the EPC calculation it should be full closure of the total IUF, i.e. the right hand column above. If you aren't following the logic of this, a quick call would probably be easiest as helping you understand my thinking is the best way to avoid QA issues further down the line.

As with the question I raised the other day I am not following the scale of uplifts suggested in your second and thirds tables below but I wonder if it is because of the above issue?

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 April 2020 12:03

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

The previous numbers you saw were accounting for total demand (instead of just SH demand). This has now been corrected and applied based on the SH:HW demand ratio (accounted for by property type and property size), resulting in an average 23% increase in savings (i.e. average 1.23 factor multiplied by the previous % savings). Please see the updated table below with the new current savings:

Measure Current Savings Previous Savings

Roof 7.46% 6.41%

Glazing 3.62% 12.00%

Floor 9.31% 8.79%

Doors 2.16% 2.00%

Replacement Door 8.00%

Draught proofing 3.40%

Reduced infiltration 2.49%

HW tank insulation 4.19%

Cavity wall 11.13%

Solid Wall 14.99%

Wall 13.24% 12.20%

Roof+Glazing+Floor+

Doors+Wall 35.80% 41.40%

Additionally, the glazing numbers are still low because they are averaged with the uplift from band E. Along the lines of your suggestion, I have changed the packages to allot for glazing from band G (Single glazed) to be in both the medium and high packages. However, I have set the glazing from band E (Double glazed pre 2002) to only be accounted for in the high package. This way, the medium package should now be more cost effective. Please see the updated package savings below:

People-led / Govt-led / Central High innovation / Max

Package Weighted Average Savings Weighted Average Savings, including performance gap uplift

Low 11.97% 15.21% 16.83%

Medium 17.79% 22.31% 24.57%

High 29.13% 36.31% 39.91%

Finally, regarding the clarification on IUF uplifts, I believe we are aligned. For the scenarios, we are only using a partial uplift (of the total IUF factor; i.e. 1/3 or 1/2 depending on the scenario). However, for the EPC calculation, we are using the SAP uplift which is a full closure (of the total IUF factor). Please see the example below of a ETT cavity wall insulation being applied to a medium-sized, semi-detached dwelling in the Govt-led scenario:

UCL savings (based on gas consumption) UCL savings (after accounting for SH only) Model Savings SAP Savings

Percent 8.9% 11.0% 14.6% 22.0%

Factor applied from previous number - 1.23 1.33 1.50

The SAP savings of 22%, when compared to the UCL savings after accounting for SH, is double (or a 200% increment). This is in-line with a full performance gap closure based on the total IUF of 50% for CWI (i.e. $11\% \times 1/(1-50\%)$). The model savings (in this case the Govt-led scenario) is a partial closure (1/3) of that full performance gap.

I hope that is all clear. Please let me know if you have any further questions. Hopefully we should see increased savings and uptake of energy efficiency measures in the upcoming runs.

Cheers,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk> <mailto:[Email address redacted]@theccc.org.uk>;

Sent: 07 April 2020 08:49

To: [Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Thanks for doing the comparison, really helpful. I am confused about why glazing savings are so low, in [Name redacted]'s spreadsheet they are in the 4-7% range for an upgrade from band G? We would expect this % to be even higher once set against the baseline for space heat demand only which I understand you are doing in the application process?

If we think glazing is at risk of making packages not cost effective, we could consider removing upgrades from band E windows and focus on band G only? Equally we could try removing the door from the packages if we think that would help?

To clarify, we should not be using total IUF uplifts for determining the actual energy savings in any of the scenarios – we should only be using the partial uplift of the IUFs discussed. This is because for scenario savings we are trying to uplift from real world savings now, to what might be achievable.

For the EPC calculation in both the policy and scenario runs, SAP works on the basis of modelled savings. This means that we should be using the total IUF (accounting for any uplift already incorporated) for the EPC calculation only. Hopefully that clarifies your question too [Name redacted]?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 06 April 2020 20:15

To: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>&

Cc: [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&; [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&

Subject: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Looking further into the Energy Efficiency (EE) cost and savings discrepancies from our prior work, please see the table below which compares (on a like-for-like measure basis) the savings and costs for the current and previous models (weighted averages using the savings and stock in each archetype where applicable). The general trend is that our current work accounts for lower savings yet higher costs. The trends we discussed this morning are likely (in-part) due to this.

The biggest difference is the glazing savings and the option of a replacement door in the previous work (deep package), where we only offer door insulation. As such, the total % savings in the packages is lower with higher costs.

Measure	Current Savings	Previous Savings	Current Costs	Old Cost
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Glazing	2.92%	12.00%	£ 5,707	£ 5,456
Floor	7.61%	8.79%	£ 3,955	£ 3,946
Doors	1.74%	2.00%	£ 1,763	£ 349
Replacement Door		8.00%		£ 3,038
Draught proofing		2.76%		£ 192
Reduced infiltration		2.01%		£ 48
HW tank insulation		3.35%		£ 90
Cavity wall	8.99%		£ 3,997	
Solid Wall	12.12%		£ 6,645	
Wall	10.70%	12.20%	£ 5,443	£ 5,082
Roof+Glazing+Floor+				
Doors+Wall	29.01%	41.40%		
			£18,165	
			£15,621	

However, now that we have moved from using in-use IUFs to the total IUFs, we should ideally see an increase in EE savings in the future runs (see attached performance gap uplift file). The savings we should see in each package are summarised below:

	People-led / Govt-led / Central High innovation / Max		
Package	Weighted Average Savings	Weighted Average Savings, including performance gap uplift	
Low	9.65%	12.26%	13.56%
Medium	15.61%	19.57%	21.56%
High	23.57%	29.39%	32.29%

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk <[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkDthefgCY%3D&reserved=0)>

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Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]

Sent: 08 April 2020 12:04

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Thanks [Name redacted], some thoughts below – happy to discuss any of them if you think a more efficient way to agree way forward:

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 08 April 2020 11:18

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

We accounted for the minor changes per your latest email on this. Please see the updates in bold below.

Additionally, to increase the uptake of energy efficiency measures, I have included options below in blue to support your latest thoughts.

Please let us know what you think is best about these last few items and we will run the scenarios thereafter (please see rows 19-27 in the cover sheet of the attached to confirm).

From our previous email,

- * All scenarios
 - * HP and hybrid load factors updated with the lower load factors (to test the old ones).
 - * Higher load factors in the innovation scenario.
 - * H2 boiler efficiency updated (to test moving to 87% to match gas boilers; will not affect People led).
 - * Including the technologies that can go in space constrained homes even if not in top 10 ranking.
 - * [Name redacted] has determined a set of the top 10-15 technologies and the addition of 2-3 electric resistive and storage for the space constrained and listed archetypes. This will be used in the next set of scenario runs.
 - * Energy efficiency cost/savings updated.
 - * Updated performance gap uplifts.

* Removal of double glazing (from band E) from the medium scenario (only in high scenario). Yes fine. If you think it would help cost-effectiveness I would be fine with removing all upgrades of pre-2002 double in the high scenario too, so we are only upgrading single glazing across the packages.

* Double glazing (from band G) is still in the medium scenario.

* Space constraints on high T HPs updated (unsuitable in SC homes). For my own benefit, have we got a parallel tech set here as for low temp heat pumps, e.g. high temp with heat battery? Or are we just including high temp hps with a cylinder? In which case this assumption change sounds right.

* Force High packages in all Fuel poor homes (where technically suitable). Might this actually lead to a fairly limited no? Do you think we should alter to giving all FP homes the highest package that is technically suitable for them?

* High-innovation scenario

* Use low H2 price by removing H2 storage cost for the model run (so uptake in hybrids may be higher). Am I right in thinking that in the absence of this change, we would expect v low hybrid uptake in innovation led (as per [Name redacted]'s cost effectiveness assessment), or will we only be able to compare by running the scenario with both prices?

Additionally,

* People-led scenario (aim to achieve around ~25% energy efficiency savings)

* Force in the high package in all homes where suitable.

o Could this also be forcing in lots of mediums? I think in net zero we still had many more mediums than high? It might be most justifiable to try to force by effectively forcing in the measures that were in net zero (will any additional measures needed to reach the 25%)?

o As an aside, is it possible to work out what savings uplifts would need to be to generate energy efficiency deployment consistent with 25% savings from EE in this scenario?

* Question: shall we remove Glazing and Doors in this case, to reduce cost, or leave them in? We would suggest leaving it in on the basis that we want to maximise savings. Happy to leave in to see what happens. Removal is more about whether adjusting the packages or assumptions in some way can help us get to 25% without forcing in.

* Other scenarios (Govt-led, high-innovation) (which do not need to achieve 25%; however, should still aim to increase EE uptake)

* Remove Glazing and Door Insulation (based on being low cost-effective measures) from all packages. I'd be inclined to keep glazing in as per bullets above because there is a fair bit of uncertainty over [Name redacted]'s assumptions and it is a fairly significant thing to suggest no homes should bother getting glazing upgrades. Note in high innovation we should be including triple glazing in the packages in place of double – but it should be at equivalent cost to double. Happy to follow same logic as

other scenarios in terms of whether single glazing upgrades only are included. If you believe removing door replacement would improve the cost effectiveness let's try removing it.

o Also worth remembering that the original intention with govt-led was to work out the level of energy efficiency which would be consistent with high hydrogen prices. I think this approach will work to increase the EE in the scenario, once we have an approach to forcing in hydrogen uptake - I am aiming to get to that after this email.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 07 April 2020 19:02

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Thanks for your notes and the updates. We have been updating what we could test. However, based on your latest email, the notes below in bold apply.

Regarding the upcoming scenario runs, we have updated the inputs to reflect the changes we propose testing. Please see the cover sheet in the attached (for today's entries) for the items that have changed. This includes the following:

- * All scenarios
 - * HP and hybrid load factors updated (to test the old ones).
 - * We can keep the lower higher load factors in the innovation scenario.
 - * H2 boiler efficiency updated (to test moving to 87% to match gas boilers; will not affect People led).
 - * We can revert to the 80% if you feel strongly that we should not account for this.
 - * Including the technologies that can go in space constrained homes even if not in top 10 ranking.
 - * [Name redacted] is looking into the latest run of all technologies with the EE package set to 'none' to identify the top 10-15 technologies and the addition of 2-3 electric resistive and storage for the space constrained and listed archetypes. This can then be used in the next set of scenario runs.
 - * Energy efficiency cost/savings updated.
 - * Updated performance gap uplifts.
 - * Removal of double glazing (from band E) from the medium scenario (only in high scenario).
 - * Double glazing (from band G) is still in the medium scenario.
 - * Space constraints on high T HPs updated (unsuitable in SC homes).
- * Govt-led only
 - * Use low H2 price by removing H2 storage cost for the model run (so uptake will be higher).
 - * Currently doing so for the Govt-led; we can change this to only in the innovation scenario.

[Name redacted] will get back to you separately on the updates regarding the level of energy efficiency uptake and the latest policy run.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Sent: 07 April 2020 18:05

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi all,

I'm just dropping you a brief email on the outputs of my chat just now but will hopefully be able to share some more comprehensive thoughts later:

- Load factors

- o We do want to see what the impact is of changing the load factors back to the old assumptions, we can then use the findings to decide how to apply. We would definitely be using the smaller sizing (i.e. the new load factors) in the innovation scenario though I think.

- Energy efficiency

- o We definitely want all fuel poor homes to be getting high packages (and the number of FP homes should replace the 3.25 additional measures we were forcing in previously).

- o Keen to see what the policy run implies for SAP C uptake and whether that is a route for getting more EE.

o Mike (our chief economist's) view is that beyond this, we may wish to have lower EE in some of our scenarios if that is what the numbers are telling us. His steer is that we'd still want 25% in at least one scenario. I think in the other scenarios we should be increasing the level of EE where doing so results from sensible assumption adjustments (e.g. altering the technology mixes in the packages etc).

- Hydrogen

o On hydrogen, Mike is more comfortable with forcing in hydrogen along the lines of the approach we discussed, rather than fiddling with assumptions to try to get uptake. I think that means we do use the hydrogen with storage costs.

o However, can we try running the innovation scenario with the lower bound hydrogen costs to see whether that drives the hybrid uptake we are looking to represent?

o If forcing in I don't think we need to worry about changing the H2 boiler efficiency in the run at this stage (and it looks like it makes a limited difference)

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 April 2020 16:09

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted]

Thanks for the suggestion. That indeed would be an alternative to forcing hydrogen in. The fuel price data is useful to see the storage costs account for essentially the whole difference from the HTD/Net Zero study by 2050 (we knew that was the main difference but I wasn't sure if something else had changed too, as in the earlier years there is now a mix of H2 production technologies too).

We are working through the analysis of the Storage heating issue, and will come back to you with a proposed set of updated inputs for the next Scenario runs.

I hope your internal meeting goes well.

Best wishes

[Name Redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 07 April 2020 15:20

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Thanks [Name redacted].

I've also been continuing discussions on alterations we might make and there is a suggestion from central team that we could use hydrogen prices excluding storage costs to determine measure uptake for govt led, but then hydrogen prices including storage costs to determine the costs associated with that measure uptake. I have attached an updated prices workbook where I have added in low hydrogen costs in rows 387 and below for that purpose.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 April 2020 12:03

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted]

Thanks for the heads up, we have just had an internal discussion on this and anticipate the following order in terms of new insights/scenario runs:

1. Off-model analysis of impact of factors on the HP versus H2 balance; within the next ~1 hour

* We are currently producing a comparison in cost and £/t terms of the various technologies under variations in:

- i. Load factors
- ii. H2 boiler efficiency
- iii. Level of energy efficiency uptake
- iv. All of the above combined

* This will give an indication of how close the Hybrid+H2 and H2 boiler technologies can get to competing with the HPs if we updated the above factors, or if we are still likely to need to force in, or make other updates; so hopefully in itself useful for your discussion at 4pm

1. Updated Policy run with constraints relaxed to £5000+4% of property value (excluding heating system) and £200/t, and with the updated IUF application; within the next 1-2 hours

* This is also underway and will be ready shortly

2. Updated Scenarios runs with the changes to input assumptions made – this afternoon, may be after 4pm as we need to agree updates, including any to address the low uptake of storage heating

* We can then re-run the Scenarios using the updated assumptions as above in point (1)

* We can also consider updates to address the Storage heaters uptake. We have done some initial analysis of this and have identified that:

i. This is as suspected partly to do with High T HPs being allowed in space-constrained homes – an error, we need to correct this

ii. Even then, low uptake of Storage heaters may persist due to the fact that Resistive heating is now lower cost or similar cost to storage heating, certainly in the Flexible case and even in the Inflexible case in many homes, due to the lower electricity costs again. In the “partial” space constrained homes, the Communal systems and GSHPs are also lower cost than Storage heaters. We will need to explore this further once the High T correction has been made.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>[mailto:[Email address redacted]@theccc.org.uk]>

Sent: 07 April 2020 10:14

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>[mailto:[Email address redacted]@element-energy.co.uk]>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>[mailto:[Email address redacted]@element-energy.co.uk]>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>[mailto:[Email address redacted]@element-energy.co.uk]>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi all,

Just to let you know timings, I have a chat with our Chief Economist at 4 today to talk about scenario end points amongst other things. Ideally I would be keen to have a view on what movement we could get through reasonable assumptions changes vs where we might have to force in – do you think you will be in a position to provide my more insight from your runs on the range of points ahead of this meeting?

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 07 April 2020 08:49

To: '[Name redacted]' <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Thanks for doing the comparison, really helpful. I am confused about why glazing savings are so low, in [Name redacted]'s spreadsheet they are in the 4-7% range for an upgrade from band G? We would expect this % to be even higher once set against the baseline for space heat demand only which I understand you are doing in the application process?

If we think glazing is at risk of making packages not cost effective, we could consider removing upgrades from band E windows and focus on band G only? Equally we could try removing the door from the packages if we think that would help?

To clarify, we should not be using total IUF uplifts for determining the actual energy savings in any of the scenarios – we should only be using the partial uplift of the IUFs discussed. This is because for scenario savings we are trying to uplift from real world savings now, to what might be achievable.

For the EPC calculation in both the policy and scenario runs, SAP works on the basis of modelled savings. This means that we should be using the total IUF (accounting for any uplift already incorporated) for the EPC calculation only. Hopefully that clarifies your question too [Name redacted]?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 06 April 2020 20:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: EE Cost & Savings - Previous Data vs. Current Model

Hi [Name redacted],

Looking further into the Energy Efficiency (EE) cost and savings discrepancies from our prior work, please see the table below which compares (on a like-for-like measure basis) the savings and costs for the current and previous models (weighted averages using the savings and stock in each archetype where applicable). The general trend is that our current work accounts for lower savings yet higher costs. The trends we discussed this morning are likely (in-part) due to this.

The biggest difference is the glazing savings and the option of a replacement door in the previous work (deep package), where we only offer door insulation. As such, the total % savings in the packages is lower with higher costs.

Measure	Current Savings	Previous Savings	Current Costs	Old Cost
Roof	6.04%	6.41%	£ 1,296	£ 787
Glazing	2.92%	12.00%	£ 5,707	£ 5,456
Floor	7.61%	8.79%	£ 3,955	£ 3,946
Doors	1.74%	2.00%	£ 1,763	£ 349
Replacement Door		8.00%		£ 3,038
Draught proofing		2.76%		£ 192
Reduced infiltration		2.01%		£ 48
HW tank insulation		3.35%		£ 90
Cavity wall	8.99%		£ 3,997	
Solid Wall	12.12%		£ 6,645	
Wall	10.70%	12.20%	£ 5,443	£ 5,082
Roof+Glazing+Floor+				
Doors+Wall	29.01%	41.40%		
			£18,165	
			£15,621	

However, now that we have moved from using in-use IUFs to the total IUFs, we should ideally see an increase in EE savings in the future runs (see attached performance gap uplift file). The savings we should see in each package are summarised below:

	People-led / Govt-led / Central High innovation / Max		
Package	Weighted Average Savings	Weighted Average Savings, including performance gap uplift	
Low	9.65%	12.26%	13.56%
Medium	15.61%	19.57%	21.56%
High	23.57%	29.39%	32.29%

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

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From: [Name redacted]

Sent: 14 April 2020 08:08

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: FW: CCC 6CB: Input on technical limits to deployment of energy
efficiency

Attachments: UKPN response to CCC trajectories

Morning all,

Hope you had lovely Easter weekends and managed to enjoy some of the sun!

Great to see some very helpful feedback coming back on trajectories so thanks for all the work that went into getting emails out on this. I've attached also some feedback from UKPN.

Would it be possible for someone to get an email out to the top 5 gas boiler manufacturers today (excluding Worcester Bosch) to test their views on the hydrogen boiler deployment timeline? I think we'd want to test date of mandation, how much notice is needed (i.e. when the regulations should be set) and what ramp up rates should be? I note that the ENA paper mandation date is 2026 so suspect for our purposes that is better as a working assumption than 2025? We might also want to cut down the justification wording (given it only reflects feedback from Worcester Bosch) and change to something along the lines of:

'The first prototype Hydrogen boilers are already developed by the likes of Bosch and Baxi, and other manufacturers are active. It is assumed that the first HyReady products are likely to be available on the market within the next few years and that a full switch to HyReady boilers could be achievable well before 2030.'

I also wonder if it is worth an email to the HPA and GSHPA to get feedback on heat pump deployment rates, perhaps after any updates made on the basis of [Name redacted]'s feedback below?

Thanks,

[Name redacted]

From: [Name redacted][mailto:[Email address redacted]@e3g.org]

Sent: 13 April 2020 21:35

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: Re: CCC 6CB: Input on technical limits to deployment of energy efficiency

Hi [Name redacted],

Thanks for getting in touch. Hope you're keeping safe and well and have had a good Easter weekend! Sorry for this long email, but have attempted to keep my feedback well-organised by technology – they're mostly around heat. There's a few questions in there as well – not too many, and answers welcome when you get a chance.

How are these assumptions being connected with related boundary conditions for changes to the energy system outside the home? (E.g. hydrogen conversion, grid development)

Insulation – the figures seem sound to me, with a few caveats:

- I don't quite follow why the cumulative numbers go up to the total deployed (i.e. including that already deployed) instead of remaining potential – can you explain? Does it mean that the number achieved by 2025 (for lofts and cavities) are therefore not actually full remaining potential insulated? And how does this square with previous (assume to be updated) CCC benchmarks for getting all basic insulation measures done by now?
- The time it takes for loft and cavity wall insulation to ramp up to previous CERT/CESP peaks seems long when it might be easily achievable (considering speed of ramp up in CERT/CESP era). Is searching in an environment of less remaining potential an explanation for this? Is that also why solid wall rates get to previous peak more quickly?
- Lofts specifically: can you clarify what the threshold assumption is for remaining potential (in terms of loft thickness)?
- Is there a way of incorporating heating into whole house retrofit (and vice-versa) for this exercise?

On heat:

Heat pumps (incl. hybrids):

- Given the scale of deployment in last year's Net Zero report for new build (as you mention) – 1 million by 2025, 2.6m by 2030, 5m by 2035 – the annual retrofit rates for heat pumps are very low in terms of what could be 'easily achievable' and 'achievable at a stretch' by 2025. 1m in new build by 2025

would imply an average of 200,000 per year. That sort of scale would easily translate into higher deployment rates for retrofit.

- o I note the HPA's roadmap you reference, as the basis for your 'by 2025 figure under 'achievable at a stretch', therefore higher deployment rates for retrofit that build on a new build supply chain, would rely on strong government signals for heatpumps in retrofit as well as new build (which we appear to be getting). This highlights the misalignment in assumptions underpinning annual retrofit figures between H-boilers and everything else on the list.

- Can you factor in evidence from other heat pump markets, and their growth rates, into the assumptions and figures for heat pumps? You do this for solar thermal, which really helpfully anchors your assumptions.

Hydrogen / 'Hyready' boilers:

- They have by far the highest possible annual deployment rate but are the only technology in the list for which viability is still being tested. All others are mature.

- o In this context, the figures of 4m per year are staggering, especially where couched as 'Easily achievable' or 'Achievable at a stretch' – and seen against the current backdrop of 1.6m gas boiler replacements a year, to which other heating system deployment figures (all mature technologies) are pegged.

- o The industry, as the source of the 4m figure, would be setting itself up for the mother of all cliff-edges. There is a parallel experience with automotive hydrogen – while not written off, the car industry's unfulfilled hydrogen proposition set back BEV market growth unnecessarily.

- Given it is not available in the market, the underpinning assumption on slide 8 is qualitatively very different from the assumptions for all the other cells in the table on slide 3, which start from evidence.

- o The assumption underpinning the high annual deployment limit of 4 million – “with a hard regulatory signal and given sufficient notice” – could apply to any of the other technologies to justify far higher resultant supply chain capacity. Therefore deployment limits seem out of line, relative to everything else.

- o Better/additional bases for assumptions here (in addition to boiler industry consultation) might be available – for example Logistics of Hydrogen Conversion<https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760508/hydrogen-logistics.pdf>, by Frazer-Nash for BEIS in 2018.

- The boilers themselves are not a turnkey solution for decarbonisation: I understand these assumptions do not look at energy system changes needed for hydrogen outside of the home – but there is more than boiler replacement (and later burner swap out which in itself would probably be simple) that needs to happen in the home for them to be able to use hydrogen. E.g.:

- o The current market / supply chain for replacing existing gas pipework is small relative to the gas boiler replacement market. Shouldn't that and related

pieces be part of the hydrogen row, or perhaps a separate row in the same group as 'Radiators / wet systems'?

- I understand these are boundary conditions to help shape the scenarios, but I'm very concerned the treatment of H-boilers here is completely out of step with its maturity – we don't even know if it's feasible at scale: it embeds the notion in modelling, led by boilers not yet available that would start off with natural gas, that hydrogen for heat is a relative cakewalk when it is not. This trickles through and can easily be misinterpreted, raising the risk that policy gets designed for technology that doesn't exist yet, not to mention countless critical dependencies upstream in the energy system that decision-makers and stakeholders often don't properly appreciate. This poses a risk to the transition overall.

Bio LPG:

- The 'strong policy signal' dimension is in here as well as in the hydrogen assumption – underpinning assumptions seem uneven as a result.

- The cumulative numbers are very high in relation to:

- o The carrying capacity for sustainable biofuel production (which I appreciate might be an exogenous consideration here)

- o The total number of homes currently using LPG. Why is biodiesel not the equivalent technology for the 1.9m oil-heated homes? I can understand where Calor is coming from on this.

Finally, was curious to ask how you're treating heat networks treated in respect of retrofit?

Hope this is useful, and look forward to learning about how the process is evolving.

Best

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Date: Tuesday, 7 April 2020 at 10:45

To: [Name redacted] <[Email address redacted]@e3g.org>;

Cc: "[Email address redacted]@theccc.org.uk" <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: CCC 6CB: Input on technical limits to deployment of energy efficiency

Dear [Name redacted]

Many thanks for your very helpful inputs to date on our work for the CCC's 6th Carbon Budget with [Name redacted].

We are now in the process of developing the scenarios, and wondered whether you may be able to provide some input to help us refine these. As part of this step, we have developed some straw-man assumptions on the feasible rates of deployment of technologies with various stakeholders, and we would be grateful if you could provide some feedback on these. This is similar to one of the exercises we included at an earlier workshop session, but now with some more concrete numbers for you to comment on.

We would be particularly grateful for your input in relation to the energy efficiency measures, but comments on the other technology groups are also welcomed.

The attached slide pack contains our straw-man assumptions with two types of numbers:

- * On slide 3, limits on feasible annual deployment, for three timepoints (2025, 2030, 2035) and for three levels of 'ambition' – all for the residential sector only

- * On slide 4, limits on feasible total cumulative deployment, which are derived to be approximately consistent with the annual deployment figures on the previous slide

The slides include a bit of further context, but of course we'd be very happy to clarify and/or explain how we intend to use these figures. The main point to reinforce is that these are not our proposed scenario trajectories, but rather the technical limits/constraints (irrespective of cost) that we will use to help shape the scenarios.

We would be very grateful if you could share any thoughts by the end of Monday 13th April if at all possible, as we are developing the scenarios over the next two weeks.

Since these are very much preliminary figures, we would request that you could treat the document as confidential.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

w: www.element-energy.co.uk<<http://www.element-energy.co.uk/>>

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Element Energy Limited Registered in England and Wales Registered number 4646003

From: [Name redacted]

Sent: 14 April 2020 17:16

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: Thoughts for next scenario runs

Dear all,

As promised I have gone through in detail and considered some updates to try to drive adjustments to the end points across the scenarios for the next run. I have listed these below, alongside some reminders on things that were planned to be in the scenarios previously but I don't think have been implemented yet. The list of changes may evolve further once you have answered some of the questions I left with you, but these are hopefully helpful to consider and prepare in the interim. I have amended the scenario guidance doc to be consistent although you will need to look at both the email and the guidance doc to see all of the suggestions:

Across all scenarios

- Apply the energy efficiency savings uplifts to reflect closure of the performance gap as discussed
- As discussed previously, [Name redacted] had adjusted glazing savings downward between 30 and 35% (you can see the description in the data note in the attached, p49 onwards). The easiest/most accurate way of reverting to the old savings is to look at the glazing savings on tab 2.2 of the final savings spreadsheet which you should already have 'Final_Savings_aligned with CCC_QA_16032020' – these should be the figures before the downward adjustments were applied. Suggest that for all scenarios we use the glazing savings pre-adjustment. These are the savings that [Name redacted] had attributed highest uncertainty to so I think there is a case for this change.
- It seems odd to me that homes currently on communal heating systems (presumably mainly flats) would get individual heat pumps/hybrids. Would it make sense to constrain so that if on a communal heating system currently, you can only get DH or another form of communal heating system (and potentially also storage/resistive if cheaper)?

Innovation-led

- As per scenario guidance doc, all high packages should be modelled akin to Energiesprong (30 kWh/m²/yr and costs as per email exchanges with Jon Warren)
- Suggest that for all other packages, we try aligning energy efficiency costs with the lower bound to see how this impacts EE uptake. I have attached some lower bound cost assumptions for testing (not QA'd).
- I note that in the last run there were low nos of hybrids, and this is a scenario where we are keen to represent a hybrid world.
 - o One thing I am aware of is that the cost reductions we apply to heat pumps could arguably be an underestimate relative to those we apply to hybrids. The reason is that advocates of hybrids have suggested cost savings

from modularisation/plug and play models which combine both the boiler and the heat pump, improving ease of installation. At the moment we only assume hybrid cost reductions which reflect the cost savings from the decrease in heat pump costs. From the Delta EE study,

<https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/498962/150113_Delta-ee_Final_ASHP_report_DECC.pdf>

the overall 20% cost reduction assumed includes a 40-50% reduction in non-equipment costs. At the world economic forum event I attended, there was discussion of savings on installation of up to 50% from modularising. Could we try assuming that a 50% reduction in boiler installation costs are included in the hybrid costings for the innovation scenario by 2050 too?

o Alternatively/additionally, we want this scenario to be coherent with a narrative where some regions get hydrogen and others electrify. One option could be to assume that the regions in the north that got full hydrogen in gov-led get hybrids here, with other regions being electrified, and this being a route to defining how many hybrids are in the scenario?

- All boiler replacements in regions that get hydrogen are hyready from 2026.

- I would be keen to have more GSHPs in this scenario relative to people-led on the basis that heat as a service should favour more costly technologies. Do you think there are any assumptions changes we are already making, or could plausibly make which might lead to greater uptake than in people-led? If not do you have thoughts on a rationale to force in a certain no? In our various meetings with the GSHP manufacturers it has been suggested that they are installing more frequently in social housing, and they also believe they are more suitable for heritage and space constrained homes – could offer one approach to forcing if we can't implement through assumptions?

- I am keen that we see wider uptake of thermal storage in one of the scenarios, and high innovation seems the best to do it in. It doesn't seem to be getting deployed widely at the moment. Could we please consider how best to deliver? I think options are:

o Assume more ambitious cost reduction in thermal storage (p9)

o Assume every home not capable of pre-heating gets thermal storage

o Force in on the basis of a study. The OVO report<<https://www.ovoenergy.com/binaries/content/assets/documents/pdfs/newsroom/blueprint-for-a-post-carbon-society-how-residential-flexibility-is-key-to-decarbonising-power-heat-and-transport/blueprintforapostcarbonsocietypdf-compressed.pdf>> assumed 50% of electrically heated homes have 3 hrs worth of thermal energy storage although not clear whether this is in fabric of home or heat battery etc. Other options could be the CCC imperial report<<https://www.theccc.org.uk/wp-content/uploads/2018/06/Imperial-College-2018-Analysis-of-Alternative-UK-Heat-Decarbonisation-Pathways.pdf>> (reference on p32 although not sure if level of deployment is discernible from report), or potentially some reports from NG or DNOs if you are aware of any?

- There should be no full H2 boilers in this scenario

- High temp heat pumps should be permitted in this scenario but not others.

- There were bio-LPG boilers in the last run, however if you look at the prices assumptions there is a cap on use included. Please make sure this and the other caps in prices workbook are implemented in the next run.
- Assume lower bound hydrogen costs, i.e. no storage.

Govt-led

- Hydrogen technologies to be forced, in line with the 'hybrid H2 North' variant in the Imperial pathway (<https://www.theccc.org.uk/wp-content/uploads/2018/06/Imperial-College-2018-Analysis-of-Alternative-UK-Heat-Decarbonisation-Pathways.pdf>) (p25). This assumes that the main heating system in the North of GB (Scotland, North of England, North Wales) is fuelled by hydrogen (i.e. full hydrogen heat pumps on gas) while the other regions use hybrid heat pumps.
- In terms of uptake pathway:
 - o Align so consistent with industry scenarios
 - o Large scale building trials in 1-2 cities in the early 2020s. Continued pace in late 202s, with full region by region conversion after 2030. (NB I am waiting for feedback internally on this so it may change further)
 - o Start with areas that will be 100% H2 then leave the hybrid H2 areas until later in the trajectory
 - o Have a 50% higher rate of gas grid conversions in the 2040s than in the 2030s (i.e. only 40% of grids converted by 2040 – note this won't correspond to 40% of hydrogen demand by 2040 as the 2030s grids will be serving H2 boilers rather than hybrid systems.
- Use upper bound hydrogen costs (where they stay constant from 2025), with forced levels of hydrogen boiler uptake, in order to determine the levels of energy efficiency in this scenario. However central hydrogen costs/emissions to be used to determine the final costs/emissions associated with the scenario

People-led

- Maintain % of homes labelled as space constrained across scenarios, but assuming the heating systems which are 50% suitable (e.g. ASHPs with a small heat battery) become 75% suitable, and those which are 75% suitable become 100% suitable
- High temp heat pumps not allowed (only include in innovation scenario)
- Reminder that there should be no hydrogen at all in this scenario

Many thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

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151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 11 May 2020 18:43

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: Optimisation approach and hydrogen trajectory

Hi all,

Some updates on CCC steers from discussions today:

- Optimisation approach

- o Let's stick with the lifetime cost optimisation approach.

- o Our feeling is that it would be preferable to use a uniform 20 year time horizon for the NPVs for all the packages (the period over which the decarbonisation will take place given our first optimisation is run in 2030).

- o My understanding is that using a uniform time horizon is functionally equivalent to varying the timeframe (i.e. to align with heating system life) and adjusting by the stream of 1s, but please flag if you disagree with this or if this approach will be more challenging to implement for any reason.

- Hydrogen timeline

o We have a strawman view on an alternative hydrogen deployment trajectory – it will need to be sense checked further with ESC/BEIS but what do you think of the following as a basis and given the feedback?:

- Trial of 300 homes in 2023
- Trial in 3000 homes in 2024
- Decisions in 2025
- Let's keep the continuing pilots in the late 2020s although perhaps take a view on whether the scale needs to be adjusted?

Also for [Name redacted]'s benefit given a question to me on this point earlier - am I right in thinking all the £/t in the templates are all now fully aligned with the CCC guidance?

Thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

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151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 12 May 2020 16:27

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: RE: Residential buildings sixth carbon budget steering group meeting

Categories: Red Category

Hi all,

How are we doing on timings this afternoon? Are we still on track for a full run by the end of today? If so great if you could confirm whether this is expected to be trajectories as well as end points.

In parallel I am finalising the slides on trajectories for the stakeholder meeting tomorrow. I'd just like to verify where we are at with some of the key parameters for the trajectories following the feedback:

- Off gas grid phrase out: 2026 in engaged people and 2028 for other scenarios
- Hydrogen trajectory: trial of 300 homes in 2023, 3000 in 2024, decisions made in 2025, all new gas boilers hydrogen ready from 2026, further 3 pilots of 3000 homes each around industrial clusters in the late 2020s before full region by region rollout from 2030 to 2050
- Energy efficiency uptake: [For the steering group, the message was that in the early years it is driven by trigger points + scaled up to ensure sufficient deployment to support off gg decarbonisation, then in the later years subsequently driven by the EE and LCH regs. I believe for engaged people and potentially for others we were evolving to reflect the fact that people are likely to do more forward planning than we had accounted for? How have we incorporated this?]
- LCH: [To what extent is this now driven by heating system replacement vs some groups installing a new system prior to this?]
- Whole house retrofits: [How are we currently treating this in scenarios? Is it as it was for the steering group or have you refined further?]
- Any other key trajectory features I have missed?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 11 May 2020 11:54

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Residential buildings sixth carbon budget steering group meeting

Hi [Name redacted]

Having caught up with the team the plan for timings is as follows:

Investment trajectory (for prior version of Headwinds) – today PM

[Name redacted] is finishing up some updates to the template following last week’s discussion and expects to be able to produce the template including the investment trajectories this afternoon.

This will not yet include updates based on your most recent email today on the £/t methodology, but that should not impact the investment trajectories directly.

All Round 1+2 updates – late today or Tue morning

We still expect to be able to complete the full list of updates in our list by hopefully the end of today, or otherwise Tuesday AM. That includes the final items of adding the GSHP hybrids, and updating the technical potential. We will be working on those partly in parallel as [Name redacted] will lead the technical potential update, after finalising the template and investment trajectory above.

(This only excludes those still awaiting input from stakeholders i.e. input on the hydrogen and HP deployment timelines – we gave the HPA and GSHPA until end of Tue).

Updated full set of scenarios runs – Tue PM

As per the above, we expect to be able to start running the updated set of scenarios tomorrow, hopefully by early afternoon at the latest. It will take most of the afternoon to run the full set, and there are the usual caveats of the required QA, particularly as there have been a lot of changes, including the addition of new technologies, so the potential for table population errors. Therefore, we should have a first set of updated runs by late tomorrow, though we should expect there may be a need to re-run if any issues are identified.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 11 May 2020 08:57

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: FW: Residential buildings sixth carbon budget steering group meeting

Hi all,

Hope you had lovely bank holiday weekends!

Please see below for some feedback from BEIS on hydrogen. I am just speaking to others internally to get views, grateful for reflections you have too.

Also helpful to understand plans for today when you have a minute, including how you expect timings to run and whether you still anticipating being able to produce an investment trajectory for headwinds today?

Many thanks,

[Name redacted]

From: [Name redacted] (Clean Growth) [mailto:[Email address redacted]@beis.gov.uk]

Sent: 07 May 2020 11:09

To: [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>&

Subject: RE: Residential buildings sixth carbon budget steering group meeting

[Name redacted],

See below for further comments from the BEIS Hydrogen team around the rollout proposal

• What are your views on the feasibility of the first large scale buildings trial in 2023?

• There are no project proposals on the table which would enable trialling to start in 2020 (as proposed in the slides).

• The most developed proposals are H100 are they are currently proposing starting in 2023. This is plausible but still subject to various things, including funding being secured.

• A 10,000 trial starting in 2023 looks very ambitious; the need for such a large scale so early is also unclear.

• What might the early buildings trials look like?

• A potential first trial is H100 which is proposing to use a new plastic hydrogen distribution network run in parallel with the existing natural gas grid. I think they are targeting ~300 domestic properties.

• An early trial which demonstrates repurposing of the existing gas distribution grid to hydrogen is also likely to be valuable – potential for this to be rolled out slightly later than H100?

• What are your views on the issue of hy-ready boiler deployment and how it should be represented?

• There is no agreed policy position on this. Would be interesting to explore the benefits of mandating H2-ready boilers for all new boiler installs from 2026 through this modelling.

• Do you agree with the role of continued trials in the late 2020s (subject to the strategic decision)

• No agreed policy position on this. On the face of it, piloting deployment in late 2020s ahead of full roll-out later would seem helpful

• What are your views on the achievability of full hydrogen conversion by 2050? To what extent does it rely on reductions in gas flowing through the networks (i.e. via efficiency and partial electrification)?

• Build rates and the practical delivery constraints around these need to be better understood. A key question is the extent of new transmission grid required and plausible build rates for this. Similar for production and storage.

• Further work is required to establish the safety and technical feasibility of repurposing the gas grid and the modifications that would be required. We are currently working with industry partners to scope out the work required to do this.

Thanks,

[Name redacted]

[Name redacted]

Head of Heat Strategy Analysis

Clean Heat & Industry Analysis

Tel: [Telephone number redacted] | Mobile: [Telephone number redacted]

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This message has been sent using TLS 1.2

From: [Name redacted]

Sent: 13 May 2020 09:51

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: RE: Legionella

Hi [Name redacted],

We've now had feedback that it should be a minimum of a daily pasteurisation cycle of 1hr duration. Are we able to adjust this for the final run? It should only affect heat pumps in engaged people as discussed.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 06 May 2020 14:00

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: Legionella

Hi [Name redacted],

Thanks for the heads-up.

We have amended this point for now, as discussed in our last conversation (removed as a behavioural change and accounted for an DHW efficiency increase for HPs operating at 50C). We can change this input as necessary if we get feedback that points to a different interpretation.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk> <mailto:[Email address redacted]@theccc.org.uk>;

Sent: 06 May 2020 12:55

To: [Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk> <mailto:[Email address redacted]@theccc.org.uk>;

Subject: Legionella

Hi all,

Just a brief update on my part of the row 23 item – we have been having trouble getting time from HSE to discuss the regularity of the pasteurisation cycle due to COVID. We have questions out to CIBSE and others but there is a chance we may have to change these e.g. to weekly pasteurisation. Just warning you now in case that affects how you do things.

Thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

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[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 13 May 2020 16:00

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: RE: For review: further steers on trajectories

Hi [Name redacted],

As discussed this is an email to set out the outstanding comments/points that have come up on the trajectories. Some are more important than others and I have tried to put in priority order to help a discussion later on prioritisation and what is achievable this week.

- Use of heat pump deployment constraints

- o Following discussions on this, grateful if you could aim to remain within achievable at a stretch as far as possible, only edging into absolute limits where necessary to hit end point. Great if you could flag to us where and how much rates exceed above achievable at a stretch so we can take a judgement if needed.

- Date by which sufficient energy efficiency must be installed

- o As discussed, are you able to consider if there is any evidence (supply chain ramp up rates and deployment constraints) we can use to inform an earlier, feasible date for this in each segment? We know Scotland<<https://www.gov.scot/binaries/content/documents/govscot/publications/consultation-paper/2019/12/energy-efficient-scotland-improving-energy-efficiency-owner-occupied-homes/documents/energy-efficient-scotland-improving-energy-efficiency-owner-occupied-homes/energy-efficient-scotland-improving-energy-efficiency-owner-occupied-homes/govscot%3Adocument/energy-efficient-scotland-improving-energy-efficiency-owner-occupied-homes.pdf>> are going for 2024 although we wouldn't expect supply chains would make this achievable across the stock. If not we may just need to try to pick some dates.

- Owner occupier trigger points
 - o Am I right in thinking you are currently aligning to point of sale? Linking to points made earlier but also in the steering group, are we able to build in renovation as a trigger point (which also allows us to account for fact people are not myopic?) This could just be engaged people.
- Whole house approach
 - o Are we able to adjust the assumptions here as follows?

Engaged people Headwinds Widespread innovation

Whole house retrofit vs. incremental retrofit PRS Incremental (different EE measures taken up at different rates) to 2030 Incremental (different EE measures taken up at different rates) to 2030 Incremental (different EE measures taken up at different rates) to 2030

SH Whole house to 2030 Incremental to 2030 Whole house to 2030

OO Incremental to 2030 Incremental to 2030 Incremental to 2030

- Heating system replacements
 - o Consider these as part of deployment constraints (i.e. no of heat pumps per year must take into account heat pump replacements too)

Thanks very much,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

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151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 15 May 2020 15:22

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: Still awaiting confirmation

Hi all,

I am still waiting for confirmation on approach (suspect people are in meetings) but in the meantime a selection of things to check for the final runs:

- Bio emissions
 - o You may already be doing this, but please use "Accounting" CO₂ combustion emissions, CH₄ combustion emissions, and N₂O combustion emissions and class them as direct emissions. I mentioned indirect on an email previously but this was in error.
- Hydrogen in widespread innovation
 - o Given low incidence, and providing we have confidence in the last set of runs, this needs to be removed
- Optimisation criteria
 - o Lifetime cost (numerator of new measure £/t) based on 20yr time horizon
- Legionella
 - o Model to assume daily pasteurisation cycle of 1hr is needed. This behavioural measure should only apply to heat pumps in engaged people.
- Preheating
 - o As per scenario guidance 250320, for engaged people and widespread innovation it is 50% of post 1952 homes/homes with equivalent heat demand. For headwinds it is reduced to 25%.
- Off gas grids
 - o To ensure suitability criteria set correctly
- Hydrogen costs

o We should be using the high hydrogen costs to determine the level of EE in headwinds but central hydrogen costs for the template outputs.

- Heat batteries

o Allowed in all scenarios

- Delay onset of heating

o Remove measure from scenarios

- Communal heating

o Good to know what we ended up doing with this following feedback from [Name redacted] and [Name redacted]

It would also be good to see a version of the model to do list as a way of understanding what has been actioned?

Thanks very much,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

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151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 15 May 2020 15:31

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: FW: SWI lifetimes

Also for info I double checked what the lifetime assumption should be for IWI (as it wasn't on the spreadsheet from BEIS) and the suggestion is that it should be the same as for EWI. [Name redacted] I think you confirmed the replacement costs would be included in the next run also?

Thanks,

[Name redacted]

From: [Name redacted] (Clean Growth) [mailto:[Email address redacted]@beis.gov.uk]

Sent: 15 May 2020 15:29

To: [Name redacted] (Science & Innovation for Climate & Energy) &[Email redacted]@beis.gov.uk;; [Name redacted] &[Email address redacted]@theccc.org.uk;; [Name redacted] (Science & Innovation for Climate & Energy) &[Email address redacted]@beis.gov.uk;

Cc: [Name redacted] &[Email address redacted]@theccc.org.uk;; [Name redacted] (Clean Growth) &[Email redacted]@beis.gov.uk;

Subject: RE: SWI lifetimes

Yes, I would assume the same lifetime for each (i.e. 36 years). But [Name redacted]'s right, there is some evidence that the lifetime of old SWI could be a longer than this. Even if there is degradation, there will still be some savings delivered after 36 years, presumably.

This is another part of the evidence base that is poor, although the need to improve is less pressing than the energy savings in NEED we discussed in our meeting this morning, given the impacts of discounting benefits beyond 36 years.

[Name redacted]

[Name redacted]

Senior Analyst, Home and Local Energy Analysis team

Tel: [Telephone redacted redacted] | Mobile: [Telephone number redacted]

[Email address redacted]@beis.gsi.gov.uk<mailto:[Email address redacted]@beis.gsi.gov.uk>

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twitter.com/beisgovuk<<https://twitter.com/beisgovuk>>

From: [Name redacted] (Science & Innovation for Climate & Energy) <[Email redacted]@beis.gov.uk<mailto:[Email redacted]@beis.gov.uk>>

Sent: 15 May 2020 14:39

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] (Science & Innovation for Climate & Energy) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>; [Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>

Subject: RE: SWI lifetimes

I was thinking of simple consistency on solid walls, and shorter may be better for the moment.

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 15 May 2020 14:37

To: [Name redacted] (Science & Innovation for Climate & Energy) <[Email redacted]@beis.gov.uk<mailto:[Email redacted]@beis.gov.uk>>; [Name redacted] (Science & Innovation for Climate & Energy) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>; [Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>

Subject: RE: SWI lifetimes

Thanks very much for the quick response [Name redacted] – just to clarify for the benefit of [Name redacted] and others my typo below, EWI is 36 years, so the proposal is to assume the same for IWI.

Thanks,

[Name redacted]

From: [Name redacted] (Science & Innovation for Climate & Energy)
[mailto:[Email redacted]@beis.gov.uk]

Sent: 15 May 2020 14:35

To: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] (Science & Innovation for Climate & Energy) & [Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>;

Cc: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] (Clean Growth) & [Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>; [Name redacted] (Clean Growth) & [Email address redacted]@beis.gov.uk<mailto:[Email redacted]@beis.gov.uk>;

Subject: RE: SWI lifetimes

[Name redacted] IWI is not exposed to weather impacts as much as the other two, although there can be moisture risks from inside the house if poorly installed. However, I think I saw something this week from our DEEP contractor saying that some old IWI he'd come across was in very good condition. [Name redacted], does that ring bells with you? More generally, these lifetimes are rather arbitrary (having been at some Green Deal meetings where they were decided by policy directors back in 2012), and there's not much difference. I'd go for the same as EWI for the moment – we might have some better evidence after DEEP has ended in a couple of years.

[Name redacted]

From: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Sent: 15 May 2020 14:13

To: [Name redacted] (Science & Innovation for Climate & Energy) & [Email redacted]@beis.gov.uk<mailto:[Email redacted]@beis.gov.uk>;

[Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>;
[Name redacted] (Clean Growth) <[Email address redacted]@beis.gov.uk<mailto:[Email address redacted]@beis.gov.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: SWI lifetimes

Hi all,

[Name redacted] and Avi, really helpful chat earlier and we’ll continue to think about what we might be able to say on EPCs.

In relation to SWI we are in the process of forming an approach which tries to keep options open on the correct level but I do have a slightly urgent q on the attached lifetimes that I want to verify before we do our next model run.

I’ve just spotted that the attached lifetime assumptions don’t actually include IWI. Do you consider we should assume IWI has the same lifetime as EWI at 46yrs or as CWI at 42, or that it doesn’t need replacing?

Many thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate

Change<[https://eur02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2F&data=02%7C01%7C\[Email address redacted\]@beis.gov.uk%7C29121db8fc794be3869e08d7f8d54b0f%7Ccbbac700502c143ebb497e6492d1b2dd8%7C0%7C0%7C637251467273937347&sdata=l3xfgHUyi2PCTSNffpNI2b9I%2Bvss8yEY6aMudIPZJ0E%3D&reserved=0](https://eur02.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2F&data=02%7C01%7C[Email address redacted]@beis.gov.uk%7C29121db8fc794be3869e08d7f8d54b0f%7Ccbbac700502c143ebb497e6492d1b2dd8%7C0%7C0%7C637251467273937347&sdata=l3xfgHUyi2PCTSNffpNI2b9I%2Bvss8yEY6aMudIPZJ0E%3D&reserved=0)>

[Telephone number redacted] |
@theCCCuk<[https://eur02.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=02%7C01%7C\[Email address redacted\]%40beis.gov.uk%7C29121db8fc794be3869e08d7f8d54b0f%7Ccbac700502c143ebb497e6492d1b2dd8%7C0%7C0%7C637251467273947303&sdata=umLYCgxuwE7sPXq8C5tZ2Ra07Ttz973dNYJhBh%2BR3KI%3D&reserved=0](https://eur02.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=02%7C01%7C[Email address redacted]%40beis.gov.uk%7C29121db8fc794be3869e08d7f8d54b0f%7Ccbac700502c143ebb497e6492d1b2dd8%7C0%7C0%7C637251467273947303&sdata=umLYCgxuwE7sPXq8C5tZ2Ra07Ttz973dNYJhBh%2BR3KI%3D&reserved=0)>
151 Buckingham Palace Rd, London SW1W 9SZ

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This message has been sent using TLS 1.2

From: [Name redacted]

Sent: 18 May 2020 08:31

To: '[Name redacted]'

Cc: '[Name redacted]'; '[Name redacted]'

Subject: RE: Still awaiting confirmation

Hi [Name redacted],

Thanks very much for this, a couple of qs reading through:

- Row 15

o Description said 'Please also align to BEIS's recommended load factors for gas oil and H2 boilers based on [Name redacted] Culling's feedback on assumptions log at project outset. BEIS think we are undersizing gas and H2 boilers and oversizing oil boilers.'

o Notes say 'All load factors noted have been changed and aligned to BEIS values (HPs) and assumptions log values (others).'

o Are you able to confirm whether the load factors for gas, oil and H2 boilers have been aligned with BEIS's feedback?

- Rows 33 and 34

o Helpful to make sure I understand how communal heating is being treated. Are we forcing for homes with existing communal heating and removing cost of pipe work for those homes, then allowing uptake elsewhere with cost of pipework included?

o Also good to clarify, are both the GSHP and ASHP variants based on a 10 home basis (with GSHP groundloop adjusted to cost for this?)

Following the QA, where did we get to in the assessment of whether the high costs in widespread innovation are correct? I think we established that where high packages are deployed in large homes they are expensive – I am still unclear though on why they were getting deployed if so expensive, were they still proving cost effective for these homes? If so and the costs for widespread innovation remain high, I am tempted to remove the 10% cost premium for high temp HPs again. We did it with a view to seeing if it drove a more balanced mix which it hasn’t. The view from stakeholders did seem to be that cost premiums for this tech would be eroded in the future?

Thanks very much,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 15 May 2020 19:41

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Still awaiting confirmation

Hi [Name redacted],

As promised below, please find the updated modelling to do list. Completion status is in column ‘T’ and updated notes in column ‘M’.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 15 May 2020 18:03

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-
energy.co.uk>;
[Name redacted] <[Email address redacted]@element-
energy.co.uk>

Subject: RE: Still awaiting confirmation

Hi [Name redacted],

Please find our comments noted in red below.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address
redacted]@theccc.org.uk>;

Sent: 15 May 2020 15:22

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: Still awaiting confirmation

Hi all,

I am still waiting for confirmation on approach (suspect people are in meetings) but in the meantime a selection of things to check for the final runs:

- Bio emissions
- You may already be doing this, but please use "Accounting" CO2 combustion emissions, CH4 combustion emissions, and N2O combustion emissions and class them as direct emissions. I mentioned indirect on an email previously but this was in error.
- We are doing this.
- Hydrogen in widespread innovation
- Given low incidence, and providing we have confidence in the last set of runs, this needs to be removed
- We are able to do this. [Name redacted] has followed-up on this point with some further comments/questions.
- Optimisation criteria
- Lifetime cost (numerator of new measure £/t) based on 20yr time horizon
- This is now implemented as the optimisation approach.
- Legionella
- Model to assume daily pasteurisation cycle of 1hr is needed. This behavioural measure should only apply to heat pumps in engaged people.
- This has been changed.
- Preheating
- As per scenario guidance 250320, for engaged people and widespread innovation it is 50% of post 1952 homes/homes with equivalent heat demand. For headwinds it is reduced to 25%.

- We are accounting for this.
- Off gas grids
- To ensure suitability criteria set correctly
- This was a minor naming consistency issue in one of our input tables. It has been corrected.

Hydrogen costs

- We should be using the high hydrogen costs to determine the level of EE in headwinds but central hydrogen costs for the template outputs.
- We can do this via the same method as prior runs – this will require two full end-state runs for Headwinds (as before).
- Heat batteries
- Allowed in all scenarios
- We are accounting for this.
- Delay onset of heating
- Remove measure from scenarios
- We have removed this from the behavioural measures.
- Communal heating
- Good to know what we ended up doing with this following feedback from [Name redacted] and [Name redacted]
- Based on the conflicting feedback on costs between the two, and the risk that a significant change in cost would skew a fair comparison between our other Delta EE costs, the system costs have not changed. However, both of them agreed that we should potentially model a lower ambient loop temperature (25C chosen) and a lower space-heating output temperature (50C chosen). The configuration, and its relevant input SPFs, have been changed to account for this.

It would also be good to see a version of the model to do list as a way of understanding what has been actioned?

We are finalising a couple of last items. We can send this over shortly.

Thanks very much,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 21 May 2020 15:02

To: [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]; Thompson, Mike

Subject: Energy efficiency in the central scenario

Attachments: EE medium package cost effectiveness analysis v2.xlsm; EE Cost & Savings Cost Effective Analysis v5.xlsx

Importance: High

Dear all,

Many thanks for this analysis. I have taken from it the following conclusions
– please correct if wrong:

- We have effectively defined the packages we are modelling by including everything under £600/t in 2030 on a new measure £/t basis

- If you stick with this threshold and consider how many medium packages with IWI or EWI can be applied at under £600/t in 2030 you get 4,772,498 solid walled homes. This figure doesn't seem to change when you take EWI out of the MACC curve.

- If you take this threshold and consider how many medium packages with the CWI types we model (i.e. where CWI is under £600/t) you get 2.2m homes (so close to the 2.6m technical potential). However, if you also include the higher cost CWIs that we excluded, the MACC curve changes a lot and tells us that 4.4m homes come in at under £600/t

What I think this is telling us is that:

- a) We should deploy 4.7m solid walls in central.
- b) We should deploy at least 2.2m cavities in central.

However, we have a potential problem in that we are finding that a large number of walls with high cost cavities at £633/t on an individual measure basis, do actually come under £600/t on a whole package basis. This is a concern as arguably we should be including them and it is a big no.

[Name redacted], grateful for thoughts on this. If we wanted to reinclude then there is some degree of circularity as we would then have to reconsider all measures and ensure we are being consistent in doing everything under e.g. £650/t in packages, and we would then have to rerun our technical potential and all our scenarios, drawing time away from the other tasks we need to complete for central.

Element team, if we did want to reinclude these walls, how much time might it add given the stages we'd have to go through?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]]@element-energy.co.uk]

Sent: 21 May 2020 14:05

To: [Name redacted] & [Email address redacted]]@theccc.org.uk;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: Central scenario: £/t threshold and medium package forcing

Hi [Name redacted],

Please find attached the latest analysis on measure £/t (EE Cost & Savings Cost Effective Analysis v5.xlsx) and the cost curve analysis file (EE medium package cost effectiveness analysis.xlsb), both of which use the new measure cost basis.

The by-measure £/t values should be able inform the £/t threshold to choose for the medium package cost curve. Aside from this, the package formulation should not change (a minor lowering of the £/t value was seen across all measures).

We also realise that eventually, for the narrative, we will want to understand what type of buildings fall under the threshold (e.g. Detached, Flats, big, small). This analysis can be derived from the cost curve file (archetype definitions of property type and size are noted in the Cost curve sheet) as well, or after we decide our forcing threshold. However, we wanted to send this over now so as not to hold things up.

Additionally, as discussed yesterday during our call, we have looked at the measure suitability to heritage buildings and have updated the suitability (allowing medium packages in 50% of heritage homes). Originally, because all the heritage homes were solid walled and we had ESWI previously in the medium package, this had not been changed. It is now corrected. We are also in the process of updating the relevant cost uplifts for packages in heritage homes as well considering this. These updates will also need doing for the Alternative scenarios; we've added it to our log to address after the Central/Max have been produced.

Overview of cost curve file:

For the cost curve analysis, the 'Cost effectiveness' sheet calculates the £/t for each consumer archetype. The suitability of different wall types to listed categories are defined in the 'Consumer archetype' sheet. The final cost curve is then shown in the 'Cost curve' for the selected wall types in cells J2:J8. Additionally, you can toggle assumptions on which wall type to include in which listed categories in the 'Consumer archetypes' sheet, while also filter on which wall type to include in curve in the 'Cost curve' sheet.

Summary of the measure £/t:

If it would be helpful, we are happy to have conversation later (once you have had a chance to look through these) on deciding (i) the threshold for Medium packages, to decide on a number to force in millions, and (ii) the exact approach to forcing.

Let us know your thoughts when you can.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk<[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0)>

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Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]
Sent: 22 May 2020 14:31
To: [Name redacted]; [Name redacted]; [Name redacted]
Cc: [Name redacted]; Thompson, Mike
Subject: RE: Concern on timings

Hi [Name redacted],

I suggest (unless [Name redacted] or Mike wish to jump in to correct me) that on that basis we should stick with the 1/3 closure of the performance gap in central for now. We can ask a specific q to the Champions on it and change later if needed and we have time to.

On the other numbers you are suggesting that we force:

- 2.2m CWI relative to economic potential of 2.6m
- 9.56m lofts relative to economic potential of 10.5m

Can you just confirm for [Name redacted]'s benefit whether or not the model allows any approach in the time that includes forcing for the full economic potential for CWI and lofts?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 14:22

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; Thompson, Mike <Mike.Thompson@theccc.org.uk>;

Subject: RE: Concern on timings

Hi [Name redacted],

Following up on [Name redacted]'s email, here are the specifics on the end states.

On the latest scenario guidance, there are some items which would impact the cost effective analysis we performed to determine the end state numbers below (i.e. they are interlinked). The ½ closure of the IUF and behavioural savings change (4.5%) would affect the overall savings per measure and thus impact the £/t numbers. Therefore, we would theoretically need to re-do the analysis done yesterday to determine the new cost-effective (<= £600/t) measures to force in, which is likely not feasible at this point based on the current time constraints.

However, if we are to stick with the current analysis for the basis of forcing, the following is what we suggest:

- Solid wall forcing:

- o To clarify this forcing, as we previously suggested, we would be forcing 3.04M ISWI particularly (which includes both internal solid walls in FP and internal solid walls under £600/t across the stock).

- ESWI is not part of the medium package; therefore, the number above does not include all solid walls.

- However, via forcing 'high' in the fuel poor stock, 325K ESWI will also be forced.

- Cavity wall forcing:

- o We will force 1.08M ETT CWI and 1.14M HTT CWI.

- These were the numbers presented previously as those that would be cost effective under £600/t.

- Loft forcing:

- o We can force in 9.56M lofts based on the following breakdown (row 2: non-fuel poor cost effective, under £600/t, to be forced; rows 3/4: fuel-poor segments already being forced in via 'high' packages)

Stock to Force 100 -199mm HTT	Less than 100mm ETT Less than 100mm HTT	Less than 100mm HTT	100 -199mm ETT
Non-fuel poor <=£600/t 4,665,196		2,077,989	497,621
	1,154,899		
Fuel poor >£600/t 86,046		18,676	5,161
	18,456		
Fuel poor <=£600/t 547,976		360,110	45,058
	83,815		
Total 1,257,170	2,456,775	547,840	5,299,219

Can you confirm that you are happy with the above numbers?

We will come back to you on the other changes made on the latest scenario guidance as well.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Sent: 22 May 2020 13:50

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Thompson, Mike

<Mike.Thompson@theccc.org.ukmailto:Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Hi [Name redacted]

Thanks for the email. After a brief internal chat I wanted to send an initial response on the Trajectories part of this – [Name redacted] will send a separate response on the End-state component with some questions on that.

Trajectories

On the Trajectories, the suggestion made below is somewhat simpler than I had previously understood.

The proposed updates to the EE trajectories to use the mandation dates as ‘backstops’ (fully for PRS and SH and partially for OO) are relatively simple. In fact these are quite similar to previous versions of the trajectories we had. We therefore think this update is more a matter of several hours, or up to 0.5 days conservatively, once the dates are agreed. (We suspect that the solid wall constraint may come into play here, so that may need to feed into the agreement on the dates and the [70%] assumption for OO).

We are ready to make this update to the trajectories any time from now, as otherwise all the agreed inputs for the Central scenario were complete and ready to run. However, the updated Scenario guidance on end-states obviously means we need to revisit some of those other assumptions too.

So overall this appears more straightforward than first thought and I think we can go ahead with it, though particularly given the latest updates on the end-states I suggest we review our progress against the top-down timeline later this afternoon (once we have understood the implications of the end-state updates) to check that we are happy with amount of buffer this leaves and the associated risk to the deadline next week.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 22 May 2020 12:50

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;
<mailto:[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
<mailto:[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>;
<mailto:Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Importance: High

Hi [Name redacted],

Thanks for the email. We will need to talk about the timing question further in order to take a call about what gives here.

I know [Name redacted] is on calls for the next few hours (and still isn't 100%), so in the meantime I am providing steers as far as I am able.

End states

I have included in the attached the steers for the central and max end states at this stage. We have made quick decisions on some of them so may want to refine further later if time, but these should hopefully get us a reasonable scenario. The headlines on the EE are that:

- We'd like to force the 3.04m solid walls from the MACC , which includes both all solid walls in FP and all others under £600/t
- We'd like to force in all the economic potential for cavities (i.e. all those we modelled in packages)
- We'd like to force in all the economic potential for lofts (i.e. all those we modelled in packages)

I am aware the model may not enable us to precisely do the above. If that is the case I'd be grateful for confirmation on what you could do that would get us as close as possible to this outcome.

Trajectories

As I understand it, the regulations are functioning only to bring e.g. the homes sold by 2030, up to the standard by 2030 (with additional homes doing it so that they can install LCH before their boiler breaks).

The question of whether only a small proportion of homes or a large proportion meet the required EE by the end dates is a material one, and unfortunately we think that we are likely to need some changes to the current approach.

What is unclear is the timing for doing so given your email below, and how we do so. [Name redacted]'s current thought is that at a high level:

- We are likely to want to treat the dates for PRS and SH as backstops, i.e. they all achieve their level of EE by the date.
- For OO we may want to still use an 'at point of sale' driver, but e.g. assume that in reality this drives [70]% of homes to think ahead and retrofit by that date.

Good to understand in greater detail the time implications of representing something like this. Worth being aware that we didn't manage to agree dates for use with the current format in our discussion this morning due to the above issue arising.

I am not fully following the below, so happy to either have a call this afternoon, or to wait to see a further email after you've had a bit more time to consider including in the context of the above.

I will see if I am able to get any more time with [Name redacted] to decide what to do about prioritisation. Do you anticipate getting to the trajectories today or on Tuesday?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 12:12

To: [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>&

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&;
[Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&

Subject: Concern on timings

Hi [Name redacted]

Apologies again to miss your call but good you were able to speak with [Name redacted].

I understand that an updated approach to the LCH mandation date was discussed, and [Name redacted] gave an estimate of the time taken to change the trajectories approach as at least 0.5 days. We had a brief catch up and I think it would indeed be in the range 0.5-1 day as it opens up a need to develop new trajectories for a range of technologies and differentiated on the tenure dimension which would be a new distinction for LCH. I'm sure this is in your thinking already, but I therefore wanted to point out that we are already 0.5-1 day behind our top-down schedule since we aimed to start running Central last

night. I do think it would be a significant risk to add in an extra up to 1 day of delay given the hard constraint at the end of next week.

Ideally we would stick with the current approach, but if there are doubts I wonder whether a lower risk approach (even if this is higher effort overall) would be to first obtain a Central scenario that is QA’d and acceptable in the current approach, and then if there is time consider making this update later next week. This is not ideal as the new trajectories will change the stress-tests and ‘keeping options open’ tests and it may well be more than can be accommodated in the time, but I otherwise have significant concerns that we will not meet the deadline at the end of next week with any version of the Central and Max.

I am on and off calls this afternoon but will keep checking emails and if needed I will try to find some gaps to take a call.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

w: www.element-energy.co.uk<<http://www.element-energy.co.uk/>>

Cambridge: Suite 1 Bishop Bateman Court, Thompson’s Lane,
Cambridge CB5 8AQ tel +44(0)1223 852 499

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York: Innovation Centre, Innovation Way, Heslington, York YO10 5DG tel
+44(0)1223 852 499

Lille: 14 rue du Vieux Faubourg, 59042 Lille Cedex, France tel +33(0)608 157 924

Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]
Sent: 22 May 2020 18:41
To: [Name redacted]; [Name redacted]
Cc: [Name redacted]; [Name redacted]
Subject: RE: EE proposal for Central

Hi [Name redacted],

Yes fine if that no is the one that fits with the logic (all FP SWI, then all other IWI under £600/t)

Thanks very much,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 18:38

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE proposal for Central

Hi Both,

Thanks for the quick confirmation on the plan below.

Please see the one minor fix for solid walls, highlighted in [Name redacted]'s email below. It is a very minor clarification, but it would be great if you could confirm that you are happy with it.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Sent: 22 May 2020 18:00

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE proposal for Central

Agreed – this is excellent. Thank you so much.

[Name redacted]

From: [Name redacted]

Sent: 22 May 2020 17:21

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Subject: RE: EE proposal for Central

Hi all,

That sounds like a very sensible approach, and probably as you say a good thing that all those low measures are taken up.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 17:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: EE proposal for Central

Hi [Name redacted], [Name redacted], all

I have discussed with [Name redacted] and we suggest that the following approach would be the simplest way of achieving the desired outcome, without the potential issue of interaction between HTT lofts and IWI in the Medium package.

1. Move all cavity and loft measures to the Low package, and remove “None” as an option for all archetypes so that all homes take up at least Low, and so the full remaining potential of cavity and loft is taken up

* The ‘side effect’ of this is that the other Low measures of Draught proofing and HW tank insulation would be fully taken up too, but this

seems consistent with forcing all lofts and cavities as these measures are lower in cost on average than the HTT cavities and lofts -> is this acceptable?

* The fact of moving these measures to the Low package has no other impact on the outcome of the modelling

2. Force High in all Fuel poor homes

3. Force Medium packages containing IWI in the exact archetypes identified from the cost curve analysis as being under £600/t for the Medium package, such that the total number of solid walls (IWI + EWI) is 3.04 million internal solid walls (IWI) is 3.04M; separately from this, we will have an additional 325K external solid walls insulated via the 'high' package applied to the fuel poor stock.

This would achieve the outcomes as specified below:

- We'd like to force the 3.04m solid walls from the MACC , which includes both all solid walls in FP and all others under £600/t
- We'd like to force in all the economic potential for cavities (i.e. all those we modelled in packages) i.e. 2.6 million
- We'd like to force in all the economic potential for lofts (i.e. all those we modelled in packages) i.e. 10.5 million

Does this seem an acceptable approach?

[Name redacted], I have seen your other question on why not all cavity walls were seen under £600/t and will bottom that out and come back separately on it.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Sent: 22 May 2020 16:03

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Concern on timings

Hi all,

It is the HTT cavities that are in the medium package, ETT are in the low.

[Name redacted], from your description below, it doesn't sound like this approach will stop us from forcing the 3.04m solid walls, it may simply be that we have to see how many we get from the loft and cavity packages, then work out the remainder to force to allow us to reach the 3.04m SWI?

In any event it feels like we are now all on the same page with what we are trying to do with the numbers such that a run will be possible? You mentioned [Name redacted] had some outstanding qs on the other assumptions. Available by phone if this is the quickest way to resolve them.

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 22 May 2020 16:00

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; Thompson, Mike <Mike.Thompson@theccc.org.uk>;

Subject: RE: Concern on timings

Hi [Name redacted]

Thanks very much for the clarification; glad we are on the same page.

I am happy with us forcing in CE cavities and lofts and getting the additional measures in the package coming in, because we know that total costs don't increase too dramatically in the Max, so we should hopefully still be in a sensible space.

I'm not sure I get why ETT cavities are in the medium package if they are cost negative on average.

Thanks

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 15:55

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Hi [Name redacted]

That's a fair point; previously we were only discussing forcing solid and cavity wall insulation so these did not overlap. Now we are considering forcing lofts, including HTT lofts 100-199mm which are in the Medium package, this interacts with the IWI which is also in Medium and will automatically be forced too in solid wall homes if we force HTT lofts 100-199mm.

I will need to ask the team to do an analysis to understand the overlap and whether there is a conflict with the number of SWI we want (it depends how many solid wall homes have HTT lofts 100-199mm in particular).

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>

Sent: 22 May 2020 15:46

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; Thompson, Mike <Mike.Thompson@theccc.org.uk<mailto:Mike.Thompson@theccc.org.uk>>

Subject: RE: Concern on timings

Thank you [Name redacted], are you able to clarify what this means for solid wall nos in the run? I think we had been aiming to have the SWI nos defined by the high packages for FP + SWI in packages under £600/t

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 15:40

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; Thompson, Mike <Mike.Thompson@theccc.org.uk<mailto:Mike.Thompson@theccc.org.uk>>

Subject: RE: Concern on timings

Hi [Name redacted], all

I think you are right about the measure versus package difference being the main reason in the case of cavities and lofts. In general, the two factors of (i) individual measure versus package and (ii) individual archetype basis versus average across the stock will both be having some impact:

* For low cost measures with a stock average cost well below £600/t such as ETT cavities as per your example, you are right that the main/only mechanism that would mean some of those are not included in our Medium packages below £600/t would be other measures in the Medium package pushing the package cost above £600/t.

* However, for measures with a stock average closer to £600/t such as HHT cavities, there may also be some individual archetypes in which the HHT cavity itself is above £600/t. For example, in the table below from our measure £/t analysis, it can be seen that the average cost of HHT cavities in Medium/Terrace homes is £583/t. I expect there may be some individual archetypes in this group with HHT cavity measure costs above £600/t.

Overall though, given that the stock average of the cavity and loft measures is well below £600/t for most building types, I expect you are right about the dominant factor being the difference between the measure and package basis. The other measures in Medium (IWI and suspended timber floor) are higher in average cost than the cavity and loft measures, so they are more likely to push the package over £600/t.

On this basis, deploying the full potential for cavities and lofts in the packages seems a reasonable assumption. However, as a reminder then on the modelling limitations, we are currently only able to force in a measure by forcing in the whole associated package, so we would be bringing the relevant other measures in the Medium package up to the number of cavities and lofts forced.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<[Email address redacted]@theccc.org.uk>

Sent: 22 May 2020 15:08

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Hi [Name redacted]

I think the difference is whether you look at it on an individual measure basis vs a package basis. Is so, I think we should use the former for our uptake of lofts and cavities.

This is shown most clearly when you look at the ETT cavities – it seems unlikely that we should have negative costs for a given segment, but average costs of 600/t.

Grateful if you can clarify.

Thanks

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 15:04

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk<mailto:Mike.Thompson@theccc.org.uk>>

Subject: RE: Concern on timings

Hi all

[Name redacted] has just gone into another meeting so I can respond briefly on this. I think the difference here is that:

- * The larger number of cavities and lofts under £600/t are on a stock average basis, so include some cavities and lofts at costs above that for individual archetypes

- * The smaller number of cavities and lofts is the number in Medium packages that fall under £600/t on an individual archetype basis

We can use the higher figures if that is the preferred option (both options are possible and similar effort).

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 22 May 2020 14:58

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; Thompson, Mike <Mike.Thompson@theccc.org.uk>;

Subject: RE: Concern on timings

Hi all,

At the risk of emails crossing#8230;

[Name redacted], the aim was to include all of the cavities and lofts that we included in our packages, so the 2.6m and the 10.4m (these are all the loft and cavity measures that are under £600/t on an individual measure basis).

[Name redacted], I think you are asking why when we run a MACC curve that insulates under £600/t on a package basis, we aren't seeing all of those measures come through, is that correct?

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 22 May 2020 14:50

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Thompson, Mike

<Mike.Thompson@theccc.org.uk<mailto:Mike.Thompson@theccc.org.uk>>

Subject: RE: Concern on timings

Hi all

Could I possibly sense check the story here? I'm not quite sure I follow the basis under which fewer cavity walls are cost-effective.

Here is where I thought we were:

Energy efficiency in the central scenario

I think we are getting to a much better place here:

- * We have already defined economic potential for cavity walls as 2.6m (below £600/t).

- * 1.3m ETT cavities at ~£80/t

- * 1.3m HTT cavities at ~£272/t

- * Of the remaining [2.35]m cavities, our updated NEED evidence suggests these have very high costs (e.g. over 1000/t) apart from 0.35m which are coming out at a cost of £633/t. So total technical potential is just under 5m.

- * Lofts we would like to include on the same basis. ETT lofts are cost saving and HTT are around £200/t. Based on current runs, this suggests we'll end up with around 10m roofs (mostly lofts & i.e. [9]m).

- * For these, we want to force these in even when it may be cheaper to just fit a heat pump (which is why the model is not picking them up at the moment). The logic is that they are low hassle interventions which are cost-effective and which deliver additional benefits in terms of comfort, lower bills, lower grid demands.

- * Based on a the same cost threshold, we expect to get around 3m solid walls. The solid wall estimate is highly uncertain & essentially because IWI is slightly cheaper and below £600/t, but EWI has higher benefits. Total technical potential for IWI is [7-7.5] but there are high hassle costs.

Thanks

[Name redacted]

From: [Name redacted]

Sent: 22 May 2020 14:31

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>;

Subject: RE: Concern on timings

Hi [Name redacted],

I suggest (unless [Name redacted] or Mike wish to jump in to correct me) that on that basis we should stick with the 1/3 closure of the performance gap in central for now. We can ask a specific q to the Champions on it and change later if needed and we have time to.

On the other numbers you are suggesting that we force:

- 2.2m CWI relative to economic potential of 2.6m
- 9.56m lofts relative to economic potential of 10.5m

Can you just confirm for [Name redacted]'s benefit whether or not the model allows any approach in the time that includes forcing for the full economic potential for CWI and lofts?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 14:22

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; Thompson, Mike <Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Hi [Name redacted],

Following up on [Name redacted]'s email, here are the specifics on the end states.

On the latest scenario guidance, there are some items which would impact the cost effective analysis we performed to determine the end state numbers below (i.e. they are interlinked). The ½ closure of the IUF and behavioural savings change (4.5%) would affect the overall savings per measure and thus impact the £/t numbers. Therefore, we would theoretically need to re-do the analysis done yesterday to determine the new cost-effective (<= £600/t) measures to force in, which is likely not feasible at this point based on the current time constraints.

However, if we are to stick with the current analysis for the basis of forcing, the following is what we suggest:

- Solid wall forcing:

o To clarify this forcing, as we previously suggested, we would be forcing 3.04M ISWI particularly (which includes both internal solid walls in FP and internal solid walls under £600/t across the stock).

• ESWI is not part of the medium package; therefore, the number above does not include all solid walls.

• However, via forcing 'high' in the fuel poor stock, 325K ESWI will also be forced.

- Cavity wall forcing:

o We will force 1.08M ETT CWI and 1.14M HTT CWI.

- These were the numbers presented previously as those that would be cost effective under £600/t.

- Loft forcing:

- o We can force in 9.56M lofts based on the following breakdown (row 2: non-fuel poor cost effective, under £600/t, to be forced; rows 3/4: fuel-poor segments already being forced in via 'high' packages)

Stock to Force	Less than 100mm ETT 100 -199mm HTT	Less than 100mm HTT	100 -199mm ETT
Non-fuel poor <=£600/t		2,077,989	497,621
4,665,196	1,154,899		
Fuel poor >£600/t		18,676	5,161
86,046	18,456		
Fuel poor <=£600/t		360,110	45,058
547,976	83,815		
Total	2,456,775	547,840	5,299,219
1,257,170			

Can you confirm that you are happy with the above numbers?

We will come back to you on the other changes made on the latest scenario guidance as well.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Sent: 22 May 2020 13:50

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; Thompson, Mike <Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Hi [Name redacted]

Thanks for the email. After a brief internal chat I wanted to send an initial response on the Trajectories part of this – [Name redacted] will send a separate response on the End-state component with some questions on that.

Trajectories

On the Trajectories, the suggestion made below is somewhat simpler than I had previously understood.

The proposed updates to the EE trajectories to use the mandation dates as ‘backstops’ (fully for PRS and SH and partially for OO) are relatively simple. In fact these are quite similar to previous versions of the trajectories we had. We therefore think this update is more a matter of several hours, or up to 0.5 days conservatively, once the dates are agreed. (We suspect that the solid wall constraint may come into play here, so that may need to feed into the agreement on the dates and the [70%] assumption for OO).

We are ready to make this update to the trajectories any time from now, as otherwise all the agreed inputs for the Central scenario were complete and ready to run. However, the updated Scenario guidance on end-states obviously means we need to revisit some of those other assumptions too.

So overall this appears more straightforward than first thought and I think we can go ahead with it, though particularly given the latest updates on the end-states I suggest we review our progress against the top-down timeline later this afternoon (once we have understood the implications of the end-state updates) to check that we are happy with amount of buffer this leaves and the associated risk to the deadline next week.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 22 May 2020 12:50

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;
<mailto:[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
<mailto:[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>;
<mailto:Mike.Thompson@theccc.org.uk>

Subject: RE: Concern on timings

Importance: High

Hi [Name redacted],

Thanks for the email. We will need to talk about the timing question further in order to take a call about what gives here.

I know [Name redacted] is on calls for the next few hours (and still isn't 100%), so in the meantime I am providing steers as far as I am able.

End states

I have included in the attached the steers for the central and max end states at this stage. We have made quick decisions on some of them so may want to refine further later if time, but these should hopefully get us a reasonable scenario. The headlines on the EE are that:

- We'd like to force the 3.04m solid walls from the MACC , which includes both all solid walls in FP and all others under £600/t
- We'd like to force in all the economic potential for cavities (i.e. all those we modelled in packages)
- We'd like to force in all the economic potential for lofts (i.e. all those we modelled in packages)

I am a conscious the model may not enable us to precisely do the above. If that is the case I'd be grateful for confirmation on what you could do that would get us as close as possible to this outcome.

Trajectories

As I understand it, the regulations are functioning only to bring e.g. the homes sold by 2030, up to the standard by 2030 (with additional homes doing it so that they can install LCH before their boiler breaks).

The question of whether only a small proportion of homes or a large proportion meet the required EE by the end dates is a material one, and unfortunately we think that we are likely to need some changes to the current approach.

What is unclear is the timing for doing so given your email below, and how we do so. [Name redacted]'s current thought is that at a high level:

- We are likely to want to treat the dates for PRS and SH as backstops, i.e. they all achieve their level of EE by the date.
- For OO we may want to still use an 'at point of sale' driver, but e.g. assume that in reality this drives [70]% of homes to think ahead and retrofit by that date.

Good to understand in greater detail the time implications of representing something like this. Worth being aware that we didn't manage to agree dates for use with the current format in our discussion this morning due to the above issue arising.

I am not fully following the below, so happy to either have a call this afternoon, or to wait to see a further email after you've had a bit more time to consider including in the context of the above.

I will see if I am able to get any more time with [Name redacted] to decide what to do about prioritisation. Do you anticipate getting to the trajectories today or on Tuesday?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 22 May 2020 12:12

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>>

Subject: Concern on timings

Hi [Name redacted]

Apologies again to miss your call but good you were able to speak with [Name redacted].

I understand that an updated approach to the LCH mandation date was discussed, and [Name redacted] gave an estimate of the time taken to change

the trajectories approach as at least 0.5 days. We had a brief catch up and I think it would indeed be in the range 0.5-1 day as it opens up a need to develop new trajectories for a range of technologies and differentiated on the tenure dimension which would be a new distinction for LCH. I'm sure this is in your thinking already, but I therefore wanted to point out that we are already 0.5-1 day behind our top-down schedule since we aimed to start running Central last night. I do think it would be a significant risk to add in an extra up to 1 day of delay given the hard constraint at the end of next week.

Ideally we would stick with the current approach, but if there are doubts I wonder whether a lower risk approach (even if this is higher effort overall) would be to first obtain a Central scenario that is QA'd and acceptable in the current approach, and then if there is time consider making this update later next week. This is not ideal as the new trajectories will change the stress-tests and 'keeping options open' tests and it may well be more than can be accommodated in the time, but I otherwise have significant concerns that we will not meet the deadline at the end of next week with any version of the Central and Max.

I am on and off calls this afternoon but will keep checking emails and if needed I will try to find some gaps to take a call.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

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Element Energy Limited Registered in England and Wales Registered number 4646003

From: [Name redacted]

Sent: 23 May 2020 08:47

To: [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]

Subject: Technical potential cavity wall nos

Dear all,

I realised this morning that there is an error in our cavity wall technical potential, introduced by my suggested approach for accounting for insulated walls since 2015 – many apologies for this.

Essentially, I've realised the HEES table I suggested using to determine the walls insulated between 2019 and 2015 includes new build cavity walls as well. Given we are interested in the retrofit stock only this is an error. It makes quite a difference such that the technical potential for cavities becomes 5.7m and the economic potential (i.e. those we insulate in central) becomes 3.3m. It makes very little difference to the solid wall nos (as you might expect) and some difference to the loft nos. Very sorry for not twigging this before and perhaps we can discuss on Monday at what point in the to do list we need to correct this.

I've attached a corrected assessment which will need to be on the QA list too.

[Annex C]

Thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

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151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]
Sent: 26 May 2020 13:04
To: [Name redacted]; [Name redacted]; [Name redacted]
Cc: [Name redacted]; Thompson, Mike
Subject: RE: Trajectories thinking

Thanks [Name redacted]. We have just finished the meeting with [Name redacted], and the steer was to model the owner occupied sector as front end if possible (i.e. driven by real life levers). [Name redacted] was keen to see whether the 2025 date can be workable for OO EE in central.

In terms of how to model it, we are comfortable with taking a simplified approach but would like to have something which can be linked back to these real life levers and the demographics of the OO sector as far as possible. Two levers which we'd like to base it on are:

- As before a regulation saying you can't sell your home from 2025 unless it has reached the EE standard
- Requirements on mortgage lenders from 2025 incentivising them to get the average EPC of their stock up to C by 2030

[Name redacted]'s thought is that we might model it as a % of homes reaching EPC C by a certain date (2033 perhaps most logical as the LCH date?) and determining that % by looking at those captured through sales, and those captured through mortgages.

[Name redacted] did a v rough strawman calculation in the following way, but grateful if you could consider the best approach and ground it in the published stats:

- Assume a [third] of homes change hands in 10yrs
- Assume [~50%] of OO homes have mortgages
- OO homes that have no mortgage and don't change hands = $0.5 \times 1/3 = [1/3]$
- This leaves [2/3] that have mortgages or change hands, but that figure assumes that the two factors are independent variables which they aren't (Outright owners lived at their current home for an average of 23.8 years, compared to 10.0 years for mortgagors;) this suggests you are twice as likely to sell in a given year if you have a mortgage.
- Given the two categories overlap this might mean the total probability is closer to [50%] than [2/3]

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 26 May 2020 11:27

To: [Name redacted] &[Email address redacted]@theccc.org.uk>; [Name redacted] &[Email address redacted]@element-energy.co.uk>; [Name redacted] &[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] &[Email address redacted]@theccc.org.uk>; Thompson, Mike &Mike.Thompson@theccc.org.uk>;

Subject: RE: Trajectories thinking

Hi [Name redacted]

I hope you had a good weekend too.

The proposed schedule to focus on end-states today, and finalise trajectories tomorrow morning, still works for us with the update to the technical potential figures we will need most of today to be able to set up and (hopefully) run the end-states.

We will also be able to provide the guidance discussed on EE backstop mandation dates today. Since we know the uptake of the key measures (solid wall, cavity wall, lofts) in both the Central and Max since these are being specified upfront, we can make the comparison with the deployment constraints before running the end-states. We will get to this this afternoon and send through the findings when we can, which will address some of the questions you raise below. We will also consider the question on the realistic dates for OOs.

In addition, I will shortly send a note on the approach to deploying Hybrids to 2035 in the Central scenario, as there was an outstanding question on this in the guidance and slide pack you shared on Friday.

I have included the proposed high level timeplan below – we will need to keep a close eye on our progress against this and flag any delays that might put the end of week deadline at risk, and therefore may require some prioritisation.

Best wishes

[Name redacted]

High level timeplan

Tuesday 26th – End-state runs and input on trajectories

- * Update stock model to reflect corrected Cavity wall technical potential
- * Analyse the viable EE mandation dates with the new EE trajectory approach given the measure constraints (mainly solid walls)
- * Analysis the viable LCH mandation dates (mainly HPs)
- * Complete scenario input assumptions for Central
- * Run Central end-state
- * Complete scenario input assumptions for Max
- * Run Max end-state

Wednesday 27th – QA and trajectory runs

- * QA (and if needed re-runs) of Central

- * QA (and if needed re-runs) of Max
- * Agree trajectories for Central and Max
- * Agree trajectories for Alternative scenarios
- * Define technology deployment needs to keep options open for 2050 over the next 10 years (relevant for the Central scenario)
- * Complete trajectory assumptions for Central
- * Run Central trajectories
- * Complete trajectory assumptions for Max
- * Run Max trajectories

Thursday 28th – QA, scenario stress-testing and template population

- * Check trajectories do not exceed constraints for Central (based on Achievable at a Stretch?)
- * Check trajectories do not exceed constraints for Max (allowing Absolute limit if needed?)
- * Check trajectories do not exceed constraints for Alternative scenarios – without running them if needed if time is short
- * Check that Central satisfies the technology deployment needs to keep options open for 2050 over the next 10 years
- * Stress testing that the Central scenario can be met in different ways
- * Populate templates for Central
- * Populate templates for Max

Friday 29th

- * Buffer
- * Ongoing QA and refinements if possible and desirable

Black = general/applies to both Central and Max

Green = Central

Blue = Max

Red = Alternative scenarios

Yellow highlights = decision point between Element/CCC

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 26 May 2020 10:49

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; Thompson, Mike
<Mike.Thompson@theccc.org.uk<mailto:Mike.Thompson@theccc.org.uk>>

Subject: Trajectories thinking

Dear all,

Hope you all had lovely weekends and managed to enjoy the sun and get a proper rest.

Conscious we've got a busy week ahead this week - good to know timings today and order of action, when you are able to confirm.

[Name redacted] and I have had a discussion on the trajectory dates and have come to the below strawman. Our current thinking is that all the EE segments should be modelled as backstops rather than 'front ends' (i.e. the date when the reg at point of sale comes in), however this could yet change for OO which is why we've tried to think through what the front end date might be too:

	Headwinds	Innovation	Engaged people	Central	Max
Date by which sufficient energy efficiency required					
Private rented sector (Backstop):	2030	2028	2027 if possible	2028	2027 if possible
Social homes (Backstop):	2030	2028	2027 if possible	2028	2027 if possible
Owner occupiers (Backstop):	2035	2033	2030	2033	2030
Owner occupiers (Front end):	2030	2028	2025	2025-2028	2025
Date by which all new heating systems must be low carbon					
Off gas grid:	2028	2028	2026	2027	2026
On gas grid:	Full region by region conversion from 2030				
	2030	2035	2030	2033	

When we last discussed [Name redacted], you said that you felt it would be feasible to focus today on the end states and also some pre-checks on feasibility of the proposed trajectories, such that we can then provide a view the final trajectory dates by end of today/first thing tomorrow,.

If possible I think this is our preferred running order. We have a meeting with [Name redacted] at 11 and with the Scottish Govt at 3 where we are keen to discuss the trajectory dates further, including whether we should be looking to model the OO segment as a backstop or 'frontend'. We'd also like to understand your views on the feasibility of the above before we finalise. Some key questions to understand from you (amongst others):

..... Do we expect any of these dates to breach deployment constraints and if so, what is the earliest date that might be feasible?

..... Does the central still leave room for dates to be brought forward such that there can be flexibility in how to meet a carbon budget set on this basis?

..... What your view of the deliverability of the OO dates in particular? We have been thinking about assuming that all homes reach the relevant EE level by those dates. However, we are conscious that is a challenge due to the limited levers in the OO sector. An alternative could be assuming a % of homes reach the standard by that date, worked up on the basis of some of the relevant stats<https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/724323/Home_ownership.pdf> in this area (and good to know what you think some sensible % might be if you think this is a more realistic approach):

..... 63% of householders are OO

..... 34% are outright owners, mostly over 65, and have lived at their home for an average of 23.8yrs

..... 28% are mortgagors who have lived at their home for 10 years

..... Of all OO 4% expected to move in next 6 months

Clearly the 34% are the most challenging segment.

Thanks very much,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

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151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]
Sent: 26 May 2020 13:35
To: [Name redacted]; [Name redacted]
Cc: [Name redacted]; [Name redacted]
Subject: RE: Number of on-gas Hybrids by 2035 in Central

Hi [Name redacted],

Thank you, this is really helpful to see.

I discussed this trade off with [Name redacted] last week and she was most comfortable with having a 50:50 split between hybrids and full HPs on grid, even if that means we have ~3-4m hydrogen hybrids in total.

You are correct that in reality they might be distributed anywhere, which if converting to hydrogen for peak poses a problem. For the purposes of the scenario we are clearly limited to modelling hydrogen hybrids only, and given we are constrained by the modelling the thinking was that it is also ok to assume that in this instance they end up near industrial clusters. Clearly in real life they might be distributed anywhere, but equally in real life they could decarbonise by 2050 by electrifying the peaking demand if there is no H2 available. For this reason, the feeling was that we weren't too concerned by a minimum no of 3-4m.

The narrative would be that there is optionality for govt over the no of hybrids and HPs (hence the 50%) and that we see they could have benefits for a range of different types of home (which we have modelled as homes which convert to hydrogen, but they could equally be put elsewhere in real life).

In terms of linking back to the alternative scenarios nos, my thinking had been to take the no of heat pumps in new homes as a given, and to then identify the number of heat pumps off gas (perhaps taking the engaged people scenario). You could then look at the number of heat pumps left in achievable at a stretch to 2035 and divide 50:50 between HPs and hybrids.

What no does that get us to?

The reason I am a bit reticent about pinning to the no in innovation/engaged people is that the on gas part of those scenarios in particular may yet still move a bit (e.g. the 2030/2035 date for innovation).

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 26 May 2020 13:02

To: [Name redacted] &[Email address redacted]@theccc.org.uk&

Cc: [Name redacted] &[Email address redacted]@theccc.org.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&

Subject: Number of on-gas Hybrids by 2035 in Central

Hi [Name redacted]

As noted in my last email, there is an outstanding question for the Central scenario relating to the number of on-gas Hybrids that should be deployed to 2035 to be consistent with the narrative, whilst ensuring that the number is not too small as to be unrealistic in 2050 given the associated hydrogen demand. The below is the paragraph I refer to from the slide pack you shared on Friday, slide 4:

Yesterday we agreed that on gas heat pumps in central pre 2035 should be 50% hybrid and 50% full HPs. However, on further consideration this could mean we have a total of [3]m hybrids in the central scenario in 2050 using hydrogen. Is this plausible, or is it preferable to assume all of the pre 2035 deployment is hybrids such that we have at least [6]m hybrids in the mix? [NB Element, do we have an understanding from previous runs of the relative cost effectiveness of hybrids vs full HPS? I seem to remember even when we lowered H2 costs we still got v few hybrids in widespread innovation, but I am wondering if that finding was specific to the innovation scenario only?] (Yes, we expect few Hybrids to be taken up cost-effectively so these would need to be forced in).

Since few Hybrids were being taken up cost-effectively, we are very likely to need to force in the number that we require by 2035 (and have the trajectories deploy them all by 2035).

Although we can make a fair estimate, we do not know the exact number of HPs and Hybrids that will be taken up in the Central scenario until we have run it. However, we need to specify a number to be forced in before running it. To develop this estimate, we are envisaging that the number of on-gas HPs and Hybrids combined in the Central scenario is likely to be somewhere between the Engaged people and Widespread innovation scenarios (the difference between these was not very large). We have therefore made a summary table of the number of on-gas Hybrids to be forced in, under different cases:

* Basing the number on the Engaged people, Widespread innovation or an average of the two

* Assuming 50%, 75% or 100% of on-gas HP uptake pre-2035 is in the form of Hybrids

Hybrid HP forcing options for Central scenario, by 2035

Same number of on-gas HPs + Hybrids as Engaged People Same number of on-gas HPs + Hybrids as Widespread Innovation Average of these two scenarios

Hybrids make up 50% of 2035 on-gas HP uptake 4.0 mn	4.4 mn	3.5 mn
Hybrids make up 75% of 2035 on-gas HP uptake 6.0 mn	6.6 mn	5.3 mn
Hybrids make up 100% of 2035 on-gas HP uptake 7.9 mn	8.8 mn	7.1 mn

This gives a range of 4-9 mn Hybrids by 2035.

We then need to sense check this figure against the realistic minimum number of Hydrogen Hybrids that could be operational by 2035. This is different from the proposal for localised H2 clusters as in the possible addition to Max, as the narrative behind these Hybrids in Central is I think that they are widely distributed geographically. The realistic minimum is not straightforward to determine and I'm not sure we can specify this to within the factor of 2 variation implied by the 4-9 mn range in any case. However, I'd be inclined to err on the side of a larger number of Hybrids than 4 mn to reduce the risk of having a non-viable amount of hydrogen demand. This seems consistent anyway with the fact that the narrative to deploy Hybrids widely as a transitional technology is a strong part of the CCC's advice.

I'd therefore propose, for your consideration, that we could force in 6 mn Hybrids by 2035, under the assumption that this represents approximately 75% of the on-gas HPs before 2035 (note that the 75% will not be exact and will depend on the final scenario uptake; in the model, we would simply force 6 mn Hybrids without specifying the share). We would adapt the trajectories accordingly so that all the on-gas Hybrids are rolled out by 2035, and the full HP trajectory is 'slowed down' slightly to account for fact that Hybrids should account for (roughly) 75% of the uptake to 2035.

One further point to note is that this forcing can theoretically be split between the following two technologies in any proportion. Unless you suggest reasons otherwise, we would propose to specify 50% of each:

- * Hybrid (ASHP + H2 Boiler) - Flexible SH
- * Hybrid (ASHP + H2 Boiler) - Flexible SH + HW Storage

I'd be grateful for your views and/or confirmation to proceed with this assumption.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

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From: [Name redacted]

Sent: 27 May 2020 18:51

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]

Subject: RE: Trajectory dates to model

Hi [Name redacted],

Thanks, a couple of responses below. You also asked a further q on the phone just now about what to assume for OO that own their homes outright after the lenders regs come in but before the regs at point of sale come in.

If I understand correctly the question applies to all OO homes that own their homes outright before the point of sale mandation date in general (and not just after the lenders regs come in)? I would imagine that in real life, if people are told they can't sell their homes from 2028, there will be a push across that segment in people upgrading their homes, i.e. it won't just be people who actually sell in 2028 that make all the upgrades in 2028. How does that fit with the way we are modelling it?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 27 May 2020 18:14

To: [Name redacted] &[Email address redacted]@theccc.org.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&; [Name redacted] &[Email address redacted]@element-energy.co.uk&

Cc: [Name redacted] &[Email address redacted]@theccc.org.uk&

Subject: RE: Trajectory dates to model

Hi [Name redacted],

We've had a chance to look through this now and we were hoping you could confirm if you are happy with the first two points and answer the third (somewhat unrelated):

* Regarding the mortgage lender period, we are planning on using the difference in the on-gas LCH mandation date and the mortgage holder start date. This way, the policy/incentive is targeting the majority of the stock (i.e. on-gas being 82% of the stock). This would result in a period of mortgage holders uptaking EE measures of 5, 8, and 10 years for Max/Engaged People, Central, Widespread Innovation/Headwinds. Understood. This is provisionally ok but subject to the questions over some of the dates Mike has raised just now. I'll let you know as soon as I have confirmation of the dates to proceed with. Incidentally, when the lenders requirements drive things in a 5 year timeframe, what rate does that imply relative to the 1/10 you get if you just look at turnover?

* OffGG stock will be applied using the same 5/8/10 year durations, with the concept that the off-gas will need to be the earlier group. We are not going to use the off-gas LCH mandation dates (which are 1/2/3 years after 2025) as this is likely unfeasible regarding the mortgage lender incentive. We just chatted and you confirmed that the point here is that the lenders regs are assumed to bring the mortgaged stock up to the right EE level by the on gas phase out date, and not by the offgas phase out date. I think we were comfortable with this for the same reasons that you mention, namely we'd assume the off gas homes will go earlier and take up the mortgage offers first and as you say they make up a smaller proportion of the stock. However, it is important to note that in the case that the off-gas LCH mandation trajectory exceeds the EE trajectory, the EE will follow the LCH trajectory to meet the LCH uptake. Yes, where a home does not have EE but needs to install a LCH system it must install EE at the same time.

* As [Name redacted] mentioned in his email, we just wanted to confirm which H2 prices we should be using for the Max scenario?

* Widespread Innovation uses the low-cost Headwinds costs.

* Headwinds uses the normal Headwinds costs (high Headwinds costs to determine EE).

* Shall we align to the prices workbook costs for Max or should we, similar to Widespread Innovation, align to the low-cost Headwinds costs? We just discussed and agreed that there ended up being no H2 in widespread innovation in the end. I think best to use the prices workbook costs for H2 in max.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Sent: 27 May 2020 16:11

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: Trajectory dates to model

Hi all,

[Name redacted] and I have just chatted and would like to work on the following basis if possible:

Headwinds Innovation Engaged people Central Max

Backstop date by which sufficient energy efficiency required across all eligible homes

Private rented sector: 2030 2028 2027 2028 2027

Social homes: 2030 2028 2027 2028 2027

Date by which lending regulations/regulations at trigger points are implemented

Owner occupiers: 2025: mortgage holders

2030: all homes 2025: mortgage holders

2030: all homes 2025: all homes 2025: mortgage holders

2028: all homes 2025: all homes

Date by which all new heating systems must be low carbon

Off gas grid: 2028 2028 2026 2027 2026

On gas grid: Full region by region conversion from 2030 2035 2030 2033
2030

Two main things to be aware of:

* We anticipate that engaged people and max will breach
‘achievable at a stretch’ for EE, but for these two scenarios we
are comfortable with this, as long as the absolute limits aren’t breached.
Based on analysis to date we understand all of these dates should be viable?

* We are keen to formulate the OO trajectory such that it can reflect the two
levers coming in at different times – we assume this should be doable
without too much additional work? This is written up in the OO line of the table
and can be read as saying that in headwinds for example, lenders regulations
are coming in at 2025 and the regulations at point of sale are coming in 2030. For
engaged people and max, both the lenders regulations and the regs at point of
sale are coming in at the same time in 2025.

Grateful if you could let us know asap if you anticipate any issues with this
approach. Worth being aware that [Name redacted] won’t be available
tomorrow morning so from that perspective as well as a timeline perspective,
good to bottom out any uncertainties today if at all possible.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 27 May 2020 14:31

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Investigations on achievability of EE mandation dates

Hi [Name redacted],

As discussed, please see the attached file which now allows you to change cells O3 and Q3 (the backstop OO date and the OO start date respectively) and view the effect on OO uptake dynamically.

Some caveats to the file:

- * Based on best estimation of initial trajectory (e.g. 2020 to the OO start date is based on another run's curves, relating to the easily achievable deployment constraints).

- * Uptake before the OO start date may break down if pushed further than 2030 in central or 2026 in max.

- * The OO 'backstop' date is being used as a firm backstop for mortgage owners. After this date, outright owners are uptaken based on if the backstop date is also the LCH mandation date.

Happy to discuss further if the brief explanation above is not clear; I wanted to get this out to you as soon as possible.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Sent: 27 May 2020 13:17

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Investigations on achievability of EE mandation dates

Sorry one further point added below:

From: [Name redacted]

Sent: 27 May 2020 13:04

To: '[Name redacted]' <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: Investigations on achievability of EE mandation dates

Thanks very much for this [Name redacted] and end state EE is fine. EPC rating of resulting stock definitely valuable to understand for our Champions meeting on Monday so great to know what the nos are there.

I think the approach looks good. A couple of thoughts/qs:

- We are probably being somewhat pessimistic in thinking that only OO outright owners that sell will retrofit, as some proportion could also be expected to retrofit to maintain the value of their property. However clearly we don't have a basis for an assumption here. My feeling is that we could leave as is for now whilst I work through the implications for the dates and revise if we consider sensible to.

- In the way we thought about it previously, there were a number of steps to avoid double counting. My reading of the below is that this approach implicitly avoids any double counting, is that correct?

- The approach has been designed to work for the LCH date as it stands in the central scenario. In going through the dates I will need to look at the alternative scenarios at the same time; I had been doing so by just amending the SWI uptake in the central spreadsheet;. If I want to alter the front end date for the regs to meet the strawman assumptions in the other scenarios, is there a simple way to do it in the spreadsheet? I will also need to alter the LCH dates and potentially play around with this a bit. Is there a simple way you might be able to alter the spreadsheet design such that I could just change the LCH date in cell O3, and the front end date in another cell, with the formulae then feeding through?

- Because we are assuming that the mortgage regs necessarily ensure this segment of the stock reaches the right EE level by the LCH date, I think important we sense check that the rates we are seeing remain plausible. 1/8 doesn't seem overly ambitious if the rate for this segment without requirements on lenders is 1/10. However, if it looks very ambitious for other scenarios we might need to look at this a bit more closely (e.g. against rates of remortgaging).

[Name redacted], are you happy with the below? In central it leads to the full mortgaged stock being retrofitted by 2033 as the LCH date, and 64.5% of the OO stock as a whole by that date.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 27 May 2020 11:54

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: Investigations on achievability of EE mandation dates

Hi [Name redacted],

Please find attached the latest EE trajectory options file with an amended OO uptake rate.

From the perspective of our modelling, considering we do not model EPC C uptake as a driving factor, we can interpret the guidance to mean that the OO segment uptakes their end-state EE via a set trajectory based on the OO sub-segments.

Based on the EHS data [Name redacted] provided, we can say ~56% of OO are outright owners and the remaining ~44% are on a mortgage. Using these two sub-segments, we have developed two trajectories (based on their turnover rates, 10 years for mortgagors and 23.8 years for outright owners, and your guidance) and combined them into one, which we can use in the modelling.

- As before a regulation saying you can't sell your home from 2025 unless it has reached the EE standard;

- o This would imply that those likely to sell would be: $(1/10)*44\% + (1/23.8)*56\% = \sim 6.8\%/yr$ from 2025

- Requirements on mortgage lenders from 2025 incentivising them to get the average EPC of their stock up to C by 2030;

- o For this, we can amend the uptake formula above, particularly for mortgage owners (from 2025-2033, where 2033 is the LCH mandation date) to reach 100% uptake.

- Therefore, the 44% of mortgage owners would have an increased rate (1/8, instead of 1/10) until that 44% of the OO segment is completed.

- o Therefore, the new formula from 2025-2033 would look like: $(1/8)*44\% + (1/23.8)*56\% = \sim 7.8\%/yr$

..... This would result in the mortgagers having all their end-state EE installed by 2033 for central.

From 2033 onward, the EE uptake is likely to be LCH driven.

The file attached breaks this down in rows 27-29 where:

- * Row 27 is the total OO uptake trajectory (with a final possible uptake of 100%).
- * Row 28 is the OO mortgagers uptake trajectory (with a final possible uptake of 44%).
- * Row 29 is the OO outright owner uptake trajectory (with a final possible uptake of 56%).

In parallel to this analysis, we are also checking what share of homes would reach EPC C, with their counterfactual heating system and end-state EE installed, by 2030. However, to be clear, it is not currently feasible to model via the uptake of EPC directly without significantly changing the end-states; the model does not link an interim EPC rating to a trajectory. However, we do expect that the majority of homes with their counterfactual heating system and end-state EE would be an EPC C or better. For these reasons, we believe the above proxy is the best approach.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 27 May 2020 11:03

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Investigations on achievability of EE mandation dates

Thanks [Name redacted], I forgot to mention as well that I think we originally had a simplified version in mind such that rather than tying the lenders requirements to the EPC rating specifically, they would also be about getting EE ‘to the right level’. Interested to see the alternative approach too though if you have already worked up.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 27 May 2020 10:40

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Investigations on achievability of EE mandation dates

Hi [Name redacted]

Thanks very much for sending off the additional queries on the solid wall constraints.

We have had a discussion internally on the trajectories approach for the OO segment, and how this would translate into a set of updated numbers in row 27; [Name redacted] will send an email on this shortly.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>

Sent: 27 May 2020 08:54

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>

Subject: RE: Investigations on achievability of EE mandate dates

Thanks very much for responding so quickly [Name redacted] and I do hope you managed to get a proper night's sleep.

As you will have seen I have fired off a range of emails to see if we can get any more feedback on the deployment constraints themselves, given our limited confidence and their criticality in pace setting.

I will continue to look at the responses and spreadsheet you sent over yesterday now to think about an adjusted approach in the event we stick with the existing ‘achievable at a stretch’ constraint figures. I think a key determinant though is row 27 and what you assume about the rate of uptake in the owner occupied sector. Keen to understand what a more worked up version of this might look like, where led by the levers approach we have been discussing. Suspect that is probably the highest priority thing to look at first this morning when you are able.

Best wishes,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 27 May 2020 00:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Investigations on achievability of EE mandation dates

Hi [Name redacted]

Thanks for the queries and observations. I have included a partial response below, and we can follow up on the rest in the morning.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 26 May 2020 21:05

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Subject: RE: Investigations on achievability of EE mandation dates

Hi [Name redacted],

Thanks very much for this. Some observations and queries:

- Clearly solid walls remain the driving constraint
 - o How confident are we in our constraint assumptions here?
 - o I know we shared with [Name redacted], [Name redacted], BEIS and ESC (any others?). Who provided comments and were any actively in support of or against these assumptions?
 - o I have lower confidence in these constraint assumptions than for the Heat pump constraints, since while the stakeholder responses received suggested these were reasonable (see below), none of these numbers were suggested by stakeholders i.e. the current numbers are still from the original straw man I sent.
 - o I have attached the feedback we received on the energy efficiency constraints from BEIS ([Name redacted]) and [Name redacted], and also from [Name redacted] at Energiesprong (but this covers whole-house rather than the individual measures). I did not receive responses from the other stakeholders I wrote to on this. [Name redacted] noted that the figures seem sound; he had some questions/caveats, but these either related

to the Easily achievable figures or were about the technical potential numbers. [Name redacted] had some points on the technical potential too, and a comment on the Easily achievable SWI numbers, but noted “I don't have any strong views on the stretch or absolute limit figures as they seem reasonable”.

- I understand the solid walls in central to be 3.3m in total rather than the 3.04 in your spreadsheet (see [Name redacted]'s email of Friday at 18:38). My mistake, we will update.

- o According to your spreadsheet this change would seem to suggest 2029 as the earliest date for PRS and SH whilst still allowing 38% of uptake in the OO segment?

- o What is the logic behind row 27? I understand that 2028 could still be achievable in central if it was 25% uptake in OO rather than 34%? Is there a strong reason to stick with the nos in row 27 or is this something to be looked at in the context of the OO thinking tomorrow?

- o Both of the above options are viable i.e. (i) 2029 for all PRS/SH with 38% of OO, or (ii) 2028 for all PRS/SH with 25% of OO.

- o I should have explained this further – row 27 is being used in this file as a “free variable” that can be modified to test the viability of various mandation date configurations. Since the constraints only refer to the total uptake across all tenures, there is optionality around whether to deploy earlier in PRS/SH and later in OO, or vice versa, so long as the total remains within the constraints. The 38% (or 35% as I wrote it below) was determined as the maximum that would allow 2028 for the PRS/SH homes. With the corrected solid walls figure of 3.3m, the maximum OO uptake is now 25%.

- o As we further develop the OO approach tomorrow, we would need to update row 27 accordingly to check for consistency of the proposed trajectory approach across all tenures.

- I am keen to understand what the constraints imply in the other scenarios with a view to informing central

- We will check and come back to you on these in the morning

- o I understand we have 4.8m solid walls in the engaged people scenario (I understood we thought this would originally be around the 5.3 mark so good to check this as part of QA?)

- 2031 would look to be the earliest date for PRS and SH in this scenario which could also accommodate 51% roll out in OO homes

- Alternatively 2029 could be viable in PRS and SH if uptake in owner occupied at that date was as low as 13%

- o I understand we have 1.2m solid walls in innovation (did we QA this such that we are confident the number remains this low despite TIWI?)

- This would imply that you could have full deployment in PRS and SH, and partial deployment in OO homes as early as 2024

- o I understand we have 1.14m solid walls in headwinds

..... As above, this implies 2024 is a viable date

I will need to have a further detailed think first thing tomorrow because I think the solid wall constraint is throwing up some challenging dynamics. In particular it implies engaged people must be less ambitious than headwinds which is CGS consistent.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 26 May 2020 17:56

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;

Subject: Investigations on achievability of EE mandation dates

Hi [Name redacted], [Name redacted]

Thank you for sending through the latest thinking on the trajectories. These make sense from a narrative perspective. We will need to give some more thought as to how we could best model these, as I think there are some elements of higher complexity in there, particularly the mixed treatment of the OO segment whereby the trajectory is linked to EPC C for a fraction of these, but not all. We have been mainly occupied with the end-states this afternoon, so we will need to give some further consideration to the trajectories in the morning.

We have however been able to do some simple preliminary investigation of the achievability of the EE mandation dates, using the backstops for PRS and SH, and

working for now with a variable assumption on % of OO uptake addressed by certain dates.

The attached file shows a calculation estimating whether the suggested backstop dates for the Central and Max scenarios are achievable, given the relevant deployment constraints (Achievable at a stretch for Central and Absolute limit for Max).

There are a couple of caveats to note – rows 20:23 considering the impact of the different tenures, we are using a simplifying assumption that the uptake of measures by tenure will reflect the stock split by tenure, which will not be quite right. In addition, the final uptake figures may differ slightly from those shown, as the final uptake is slightly different for solid walls that the technical potential, since some heritage homes will not take it up (so the final uptake will be slightly less than the 7.4mn used here). So in general, a final correct view of this would need to be undertaken using the end-state results, but this should be a fairly accurate view.

The calculations show that:

- * For Central

- * As expected, solid walls are the driving constraint

- * It is possible to reach 100% deployment of EE measures for the PRS and SH segments by 2028, but this is only achievable if less than around 35% of the deployment in the OO segment is reached by that date (which corresponds to a linear interpolation up to around 55-60% uptake in OO by the OO backstop date of 2033)

- * Beyond that date, the backstop of OO of 2033 could be accommodated even if 100% of the OO stock were reached by then (which I understand is not the intention given recent emails). In fact, as early as 2031 the total cumulative deployment could reach the total final uptake across all tenures, so the OO date could be as early as that from the perspective of constraints

- * For Max

- * Again, the solid walls are the driving constraint

- * It is possible to reach 100% deployment of EE measures for the PRS and SH segments by 2027, but this is only achievable if less than around 25% of the deployment in the OO segment is reached by that date (which corresponds to a linear interpolation up to around 35% uptake in OO by the OO backstop date of 2030)

- * Beyond that date, 100% of the OO uptake could be accommodated by 2031 (but not 2030)

I hope this will be helpful as we finalise the trajectories in the morning.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

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Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]

Sent: 28 May 2020 14:38

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; Thompson, Mike

Subject: Decision on trajectory dates

Hi all,

Grateful if we could model the trajectories on the following basis:

Headwinds Innovation Engaged people Central Max

Backstop date by which sufficient energy efficiency required across all eligible homes Private rented sector: 2030 2028 2027 2028 2027

Social homes: 2030 2028 2027 2028 2027

Date by which lending regulations/regulations at trigger points are implemented
Owner occupiers: 2025: mortgage holders

2030: all homes 2025: mortgage holders

2030: all homes 2025: all homes 2025: mortgage holders

2028: all homes 2025: all homes

Date by which all new heating systems must be low carbon Off gas grid:
2028 2028 2026 2028 2026

On gas grid: 2035/Full region by region conversion from 2030 2035 2030
2033 2030

Note that in the end we have stuck with 2025 and 2028 for OO, but we have made a separate change which is regulating the off gas grid fossil phase out from 2028. Amongst other things we hope this gives us a bit more leeway in leaving room to reach the target if solid walls do not prove sensible.

Thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 03 June 2020 14:54

To: [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]

Subject: RE: Hydrogen demand interaction between industry and heat

Categories: Yellow Category

Thanks very much for this [Name redacted]. We had the discussion earlier where we came to an initial view on how we might handle, to be agreed and hopefully finalised in a second internal meeting at 2 tomorrow.

We got a preliminary steer to amend our high innovation scenario to include some hydrogen hybrids in the mix as well (approach TBD but good to discuss later). This means that our scenarios would end up looking as follows:

Headwinds Widespread innovation Engaged people Central Max

Approach to heating system mix High hydrogen, cost effective energy efficiency Hybrid h2, cost effective energy efficiency Fully electrified, moderate-high energy efficiency Hybrid h2, moderate-high EE Almost fully electrified, with a few localised H2 clusters that choose to convert early, max energy efficiency. Aims to reach net zero earlier.

Nos currently deployed in 2050 10m hydrogen hybrid heat pumps, 8m hydrogen boilers TBD - heat mix to include hydrogen hybrid heat pumps (located around industrial clusters) as well as high temperature heat pumps 18m heat pumps 17m heat pumps of which 4.2m are hydrogen hybrids (located around industrial clusters) 18m high temperature heat pumps and 2.9m hydrogen boilers (located around industrial clusters)

We think the headwinds and max scenarios are least problematic. However grateful if you could confirm.

- Our understanding is that headwinds hydrogen uptake is radiating out from industrial clusters in line with the industry trajectory so should be coherent across the two scenarios in terms of dates of hydrogen availability (is some boiler scrappage assumed given not everyone will have a hready boiler?).

- Max already incorporates the headwinds trajectory around industrial clusters out to 2035, are you able to confirm that the uptake we are applying (2.9m hydrogen boilers) is reasonable from an industry perspective (in terms of minimising transport costs etc)? If needed we could consider assuming wider uptake around industrial clusters

The more problematic scenarios then are engaged people, widespread innovation and central.

- We could simply assume parallel pipes to delink industry and buildings in these scenarios but would prefer to minimise this where possible. I think this means that engaged people is the main scenario where widespread use of parallel pipes is needed?

- This leaves widespread innovation and central. I am not sure I follow how using aggregate demand to influence the costs in point 2 below can be used as a clean fix, given the challenge in reconciling the nationwide picture with the regional reality?

o The issue as we see it is that in each of these scenarios, and given the way it is currently modelled, there can be expected to be homes using gas in an area after the point at which hydrogen conversion has been assumed for industry.

o The reason there will still be gas demand is that a) there will be people who have not yet had to replace their gas heating system and b) there will be people on hybrids who still don't have hydrogen ready boilers (and even when they do there is an extra stage of conversion that must take place).

o The suggestion was that it would be preferable to fix by modelling conversion to hydrogen hybrids for those homes around industrial clusters, in line with the industry conversion timeframes, such that there are no homes using gas in those areas at the relevant point in time. However, I am not sure how complicated this is to model and to what extent it has end state implications (and how much post processing) as well as trajectory modelling implications. Amongst other things I am not sure if the number of hybrids we have would avoid the need for parallel pipes.

I'd be grateful for your thoughts on whether something like this could be workable and if so what it might look like. I can then take back to the discussion tomorrow so that we can try to take a view.

All the best,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 03 June 2020 10:58

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: Hydrogen demand interaction between industry and heat

Hi all,

I have checked with the industry team and we have the following approach for accounting the cost of H2 network:

- 1) Before "grid conversion", we calculate the costs of pipelines as part of the site capex (based on distances from closest production point)
- 2) After "grid conversion" (which happens at different dates in different clusters and expands radially over time) we use the network costs in the CCC's prices workbook (attached).

It looks like this cost is demand dependent (see "H2 additional costs" tab) so potentially we could revise this between scenarios if it is provided for non heat sector H2 demand. Other components of hydrogen cost (production, storage) are not demand dependent.

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 04 June 2020 16:05

To: '[Name redacted]'

Cc: '[Name redacted]'

Subject: RE: Alternative routes to delivering the central scenario (HPs vs. SWI)

Thanks very much for all the inputs this morning and apologies there were a lot of questions/emails to navigate. Hopefully we've now been through some of the key meetings we need to go through which should hopefully make things easier.

The discussion went well as a result and I can now give some additional steers on a couple of the outstanding buildings points. I think from a knowledge management perspective probably easiest if I put these directly in the to do list. Am I ok to use the one you sent yesterday [Name redacted]?

I will try to come back today with a steer on the below if possible ;
I've got an opportunity to discuss with [Name redacted] at 5. I just wanted to quickly check my understanding and ask a couple of further questions:

Current approach

- We have an 'achievable at a stretch' deployment constraint of ~15.3m in 2035
- New homes is 5m (note your email of yesterday suggested these 5m were replacements, I think in error?), whilst off-gas HP deployment in engaged people is 1.9m
- This leaves 8.4m heat pumps being deployed on gas to 2035
- We assume half are hydrogen hybrids so 4.2 million

Suggestion based on your last email

- We align to the on gas uptake in engaged people
- This is 10.5m, 1.5m of which are off gas grid so 9m on gas grid, so 4.5m hybrids.

If I have understood correctly, you are saying that we got the deployment constraint wrong and the central to date has actually been less ambitious than, rather than more ambitious than, engaged people? On this basis, you are suggesting aligning on gas HPs in central pre 2035 to engaged people.

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You say that this also allows us to have the trajectory more front ended. We would want to be able to explain what policy level would deliver it:

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- If we moved the off gas deployment (1.9m by 2050) a year earlier it looks like it would add 126,666 HPs from 2027. Looking at your below table I'm guessing this would also deliver the savings needed?

It is quite striking that 600m HPs deliver equivalent savings over a single year to 3m SWIs over their entire lifetime, if there is any more context to help me understand why this is I'd be interested to see it!

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 04 June 2020 12:47

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Alternative routes to delivering the central scenario (HPs vs. SWI)

Hi [Name redacted],

Please see my comments in-line and the summary table below:

Deployment Year HP Operating Years (during period) Required HPs to
displace all SWI

2036	1	608,237
2035	2	304,118
2034	3	202,746
2033	4	152,059

We will respond to your more recent email shortly.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>;

Sent: 03 June 2020 19:11

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Alternative routes to delivering the central scenario (HPs vs. SWI)

Thanks [Name redacted]. The key thing from a budgetary perspective is that the total GHGs over the 5 year period must be below the budget. A few qs then:

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 - o Yes, if the ask is to offset the entire SWI savings (cumulative to 2050), the equivalent of one year of an additional savings from 600K HPs would be required.
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 - o As above, we took a yearly carbon savings per HP and then calculated the 600K based on the requirement of 1 year savings. The 600K (per the table in the main email) would be reduced based on the number of years over which we can accumulate the yearly HP savings. For example, if we want the savings over the course of the 2033-2037 period, we could have 600K installed in 2036-2037 or 300K installed in 2035-2036 (and have the two years' worth of savings).
 - o For instance if 3m SWI are installed before 2033, they will be delivering savings every year for 5 years. If 600k HPs are deployed in 2036 they will only be delivering savings for one year.
 - o Would the HP savings be sufficient to replace the SWI savings over the 5 year period even in this instance?
 - To clarify, if we are only looking to offset the savings from SWI installed during the 2033-2037 period, we would only need an additional 53K HPs to offset this savings.
- Bearing this in mind there are two concerns I have about the heat pumps being deployed at the end of the carbon budget:
 - o We need to verify it would deliver enough savings
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..... Then, we would need to force 4.5M as hybrids and change the pure HP on-grid trajectory to get 4.5M by 2035 (this was the error from before).

o Could you confirm you are happy with the forcing numbers above? (previously, we forced 4.2m hybrids).

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Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 03 June 2020 18:21

To: [Name redacted] <[Email address redacted]@theccc.org.uk>[mailto:[Email address redacted]@theccc.org.uk]>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>[mailto:[Email address redacted]@element-energy.co.uk]>>

Subject: Alternative routes to delivering the central scenario (HPs vs. SWI)

Hi [Name redacted],

As discussed, please find the details regarding the required HP uptake to offset the SWI carbon savings below. Upon looking into the year-by-year numbers, we can confirm that we are maxing out the uptake to 2035 and indeed the additional uptake required would be (and could be) uptaken in 2036 and/or 2037.

Over the total period of 2020 – 2050:

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- * This number is well within the deployment constraints.

If we are looking to offset the entire SWI savings in the 2033 – 2037 period:

- * Currently, the total HP deployment is 5.08 M, with an associated CO₂ abatement of 9.98 MtCO₂e.

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- * 2036 and 2037 HP deployment is currently 985K and 1.02M (with deployment constraints of 1.6M/yr), leaving ~1.2M spare capacity which would allow the required 600K.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk<[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkDthefgCY%3D&reserved=0)>

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Lille: 14 rue du Vieux Faubourg, 59042 Lille Cedex, France tel +33(0)608 157 924

Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]

Sent: 05 June 2020 11:42

To: [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]

Subject: Updated guidance and to do list

Attachments: Scenario guidance 050620.xlsx; Modelling to do list Central_Max -
050620.xlsx

[Annex D]

Thanks both.

Adjusting the HPs in central to allow the CB to be met in different ways

I think the approach of taking the midrange number between the minimum you could force to achieve the objectives (keep full electrification in play and have room to achieve the 6CB through early HP deployment in place of SWI), and the maximum you could force to achieve these objectives sounds reasonable.

I am not entirely following the logic for adding the 600k in the minimum (as it is about leaving room for the 600k rather than including it in our central team forced no?) – apologies if I’m being slow.

You have explained below that the SWI abatement from 2020-2050 can be offset by a total uptake of 600k HPs by 2050. I think what I am struggling with here is that having an additional 600k HPs by 2050 won’t be what delivers the additional abatement (given all heating systems are decarbonised by 2050 and we have a static no of homes). It is early deployment of those 600k that makes the difference, but the number will depend on how much earlier the deployment is. I think you are saying you need an additional 600k deployed by the end of the 6CB (although savings will be higher or lower depending on when in that period they are deployed). I can see from your table that you have included more heat pumps from 2022 onwards. Whilst this could be one way of doing it, I would rather we are able to link to clear policy levers, e.g. –the 6CB [i.e.the total GHGs over the 5 year 6CB period] could equally be met in the absence of deploying any solid wall insulation by [bringing forward the off gas or on gas low carbon heat mandation date by one year]. – Are we able to check the numbers work on this basis before finalising?

I believe (please correct me if wrong) that we are also assuming hydrogen trials progress over the 2020s, but in the central scenario we assume they are with hybrid heat pumps rather than full H2 boilers. Worth bearing this number in mind for the total hybrids you are deploying by 2035. I think we will essentially be adding to them?

In terms of the changes to the cumulative constraints, worth perhaps checking with [Name redacted] when back that there are no issues with this in the context of the stakeholder feedback.

Updates following yesterday’s discussions

Please find attached an updated scenario guidance spreadsheet in which I’ve tried to log the range of changes agreed and implemented over the

last week or two (see yellow cells), as well as some further things agreed yesterday (see orange cells, red text). Please let me know if anything doesn't look right.

I have also attached an updated to do list. This includes tasks to reflect the updates in the scenario guidance sheet, some additional tasks coming out of discussions yesterday, and also some more prioritisation including 'nice to haves'. The time calcs won't be right as my restructuring has thrown out the formulae so you'll need to correct this. Please check if any missing items in terms of misalignment of the current scenarios with the scenario guidance spreadsheet, and in the event any items in this sheet aren't aligned with the scenario guidance spreadsheet, the latter should be the right ref (I have tried to check but was striking a balance with getting this out to you quickly enough).

Please note that I am aware we have more work than the 6 working days left until the end of next week. As mentioned on the call, central team are now accepting submissions until the 22nd, but I would rather that, as before, we planned so that everything is ready and finalised by the 16/17th. We may need to need to do more prioritisation to do so and happy to pick this up next week once you've had time to digest the additional points in this email. Hopefully the nearer term priorities all make sense.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 04 June 2020 19:39

To: [Name redacted] &[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk>

Subject: RE: Alternative routes to delivering the central scenario (HPs vs. SWI)

Hi [Name redacted],

Please see our responses below.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 04 June 2020 16:05

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Alternative routes to delivering the central scenario (HPs vs. SWI)

Thanks very much for all the inputs this morning and apologies there were a lot of questions/emails to navigate. Hopefully we've now been through some of the key meetings we need to go through which should hopefully make things easier.

The discussion went well as a result and I can now give some additional steers on a couple of the outstanding buildings points. I think from a knowledge management perspective probably easiest if I put these directly in the to do list. Am I ok to use the one you sent yesterday [Name redacted]?

Yes, please do.

I will try to come back today with a steer on the below if possible – I've got an opportunity to discuss with [Name redacted] at 5. I just wanted to quickly check my understanding and ask a couple of further questions:

Current approach

- We have an 'achievable at a stretch' deployment constraint of ~15.3m in 2035
 - o Yes, this was our previous thinking '10.3M retrofit and 5M new builds.
- New homes is 5m (note your email of yesterday suggested these 5m were replacements, I think in error?), whilst off-gas HP deployment in engaged people is 1.9m
 - o This is correct. I'm not sure where/if I had mentioned 5M replacements, but that would not be correct.
- This leaves 8.4m heat pumps being deployed on gas to 2035
 - o Correct.
- We assume half are hydrogen hybrids so 4.2 million
 - o Correct.

Suggestion based on your last email

- We align to the on gas uptake in engaged people
 - This is 10.5m, 1.5m of which are off gas grid so 9m on gas grid, so 4.5m hybrids.
 - o This was the suggestion. Apologies for the back and forth on this point. We have been updating the trajectories and resolving small QA issues which have caused changes to the analysis.
- Latest numbers: Engaged People uptake by 2035: 10.6M (total), of which 2.2M is off-gas.
- o Based on this, it looks like forcing the above amount of HPs up until 2035 (when the constraints are the most stringent) is causing the trajectory to be too close to the achievable at a stretch deployment constraints. Given this, we suggest lowering the forcing until 2035 without affecting the 2050 final uptake (i.e. the uptake post 2035 could be accelerated, given that we have more buffer in those years, to 2050 to still achieve a fully electrified scenario).
- Minimum forcing:
- From Engaged People, we know that there is a 'spare capacity' (sum of [deployment constraint] ' [actual deployment]) between 2036 and 2050 of 3.1M.
- Using this, we can say that the minimum viable deployment by 2035 is 8.4M ' 3.1M + 600K = 5.9M, where 8.4M is the Engaged People deployment (on gas), 3.1M is the spare capacity (that we could move to post 2035), and 600K is the required HP uptake to offset SWI.

..... Maximum forcing:

..... For Central, the maximum possible uptake (on and off grid) for HPs according to the achievable at a stretch deployment constraints is 11.1M.

..... If we remove the 2.2M off-gas uptake, this becomes 11.1M - 2.2M = 8.9M.

..... Therefore, to be flexible, we can deploy 7.1M HPs (as the mid-point of the min/max) in Central by 2035 (of which we will force 50%, or 3.55M, as hybrids).

..... This allows for a fully electrified scenario that is within the deployment constraints by 2050.

..... This also allows for the required increase in HPs to offset the SWI during the 2033-2037 period.

..... This method also resolves the questions below.

If I have understood correctly, you are saying that we got the deployment constraint wrong and the central to date has actually been less ambitious than, rather than more ambitious than, engaged people? On this basis, you are suggesting aligning on gas HPs in central pre 2035 to engaged people.

You say that the deployment constraint in 2035 is actually 11m (presumably 11m after taking away new build?). This means that we have 500m leeway by 2035.

The above two statements are both correct; however we suggest the path as prescribed above.

You say that this also allows us to have the trajectory more front ended. We would want to be able to explain what policy level would deliver it:

- We have ~17.8m on gas homes on HPs in engaged people (including communal) in 2050. Therefore if we moved forward the on gas phase out date by one year, am I right in thinking it would deploy a further 1.2m heat pumps from 2032 so more than enough to offset the lifetime savings from SWI?

The extra uptake associated with moving the on gas phase out date forward by one year depends on the total uptake until that year (i.e. it is dependent on the remaining stock to be converted rather than the total stock number). Engaged people currently deploys 1.07M on-grid HPs a year after the mandation date.

..... Total on-grid HP uptake in Engaged People is 17.8M.

- 3.1M are deployed up to 2030 (on-grid).
- This leaves 17.8M – 3.1M = 14.7M.
- Therefore, this remaining 14.7M will be deployed at 14.7/13.8 = 1.07M/yr.

- If we moved the off gas deployment (1.9m by 2050) a year earlier it looks like it would add 126,666 HPs from 2027. Looking at your below table I’m guessing this would also deliver the savings needed? Same reasoning as above point.

It is quite striking that 600m HPs deliver equivalent savings over a single year to 3m SWIs over their entire lifetime, if there is any more context to help me understand why this is I’d be interested to see it!

Apologies on this, the outputs were misrepresented here. What we would actually need is a total uptake of ~600K deployed by 2050. Looking at the year-by-year abatement below, gives a clear picture of how many HPs need to be deployed each year.

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2031	2032	2033	2034	2035	2036	2037					

SWI MtCO ₂ e	0.00	0.05	0.09	0.13	0.19	0.27	0.36	0.49	0.63	0.68
	0.73	0.78	0.82	0.87	0.90	0.92	0.94	0.97		

Additional HP required to offset above abatement											-
27,371	27,657	26,562	31,282	48,609	56,472						
78,177	89,901	24,251	21,267	19,489	20,629	18,172					
15,852	7,116	8,262	9,393								

Cumulative HPs required to offset SWI abatement.											-
27,371	55,028	81,590	112,872	161,482	217,953						
296,130	386,031	410,282	431,549	451,038	471,666						
489,838	505,689	512,806	521,067	530,460							

Based on the above method, we are able to follow this trajectory if needed (we have buffer to do so) thus achieve the required abatement, while keeping within the deployment constraints. The most significant reason that HPs offset so much CO₂e is because they replace the counterfactual system which is a large portion of the CO₂e baseline.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 04 June 2020 12:47

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

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Sent: 03 June 2020 18:21

To: [Name redacted] <[Email address redacted]@theccc.org.uk>[mailto:[Email address redacted]@theccc.org.uk]>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>[mailto:[Email address redacted]@element-energy.co.uk]>

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Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk <[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0)>

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Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]

Sent: 08 June 2020 07:32

To: [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]

Subject: RE: High temp HPs and flexibility in scenarios

Follow Up Flag: Follow up

Flag Status: Flagged

Hi [Name redacted],

I hope you had a nice weekend. Thank you for the below.

Definitely support assuming a flow temperature higher than 60 degrees for high temperature heat pumps. How exactly did you work out that 65 is the minimum using the MCS emitter guide, and are we confident this would be sufficient to heat all homes? I am keen that we are realistic with our assumptions here as the message that high temperature heat pumps could be very cost effective is potentially quite impactful and we want to be confident in our modelling. From a quick survey of internet sources on system flow temperatures, 65 seems to be the lower end of what you would expect with a boiler:

- <https://www.viessmann.co.uk/heating-advice/what-temperature-to-set-condensing-boiler>

- o For combi boilers, the recommended output temperature for the radiators is 75 °C. The maximum temperature that we recommend you set your radiator output to is 80 °C; For [a condensing] boiler to work at its most efficient, the heat exchanger needs to be equal to or below the dew point temperature. The dew point temperature is a measurement that determines the humidity of air and is the temperature at which water droplets form in the heat exchanger. For gas boilers, the dew point is around 55 °C. This means that the water needs to be 55 °C or lower for your boiler to maintain its efficiency. The boiler's output temperature should always be higher than the dew point temperature.

- <https://www.which.co.uk/reviews/boilers/article/boiler-controls-and-thermostats>

- o It's advisable to: set your boiler temperature to 82°C in winter (between medium and high) and adjust down if radiators feel too hot, or up if not warm enough set your boiler temperature to 65°C in summer (between medium and low) and adjust down if your water feels too hot.

- <http://www.yougen.co.uk/energy-saving/Heating+Hot+Water/>

o Boiler thermostat: this should be set at 65 degrees, to enable it to deliver water of 60 degrees (see above). While radiators will get hot quicker if the boiler thermostat is set at a higher temperature, the boiler may not condense, which will reduce its efficiency by 10-20%.

- <https://www.protechboilers.co.uk/news/your-combi-boilers-ideal-temperature-for-central-heating>

o To maximise efficiency, we recommend setting your radiator dial to 75 degrees and your hot water to 60 degrees.

Interesting that the average flow temperature for conventional heat pumps is as low as 45 degrees or below ¶ I had imagined it might be higher than this. Might we be able to add a sensitivity onto the to do list relating to the MSC emitter guide given the uncertainties around it?

Am I right in thinking that the modelling approach basically installs radiators to enable the lowest flow temp possible (rather than optimising this in some way?)

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 05 June 2020 18:05

To: [Name redacted] &[Email address redacted]@theccc.org.uk&

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk&

Subject: RE: High temp HPs and flexibility in scenarios

Hi [Name redacted],

Looking into the numbers with a bit more detailed analysis, please see the below:

Conventional HP High temperature heat pump

Average flow temperature assumed in home

SH: Dependent based on heat loss factor of the archetype (~45C at peak use, lower throughout the year) SH: 65C

Combined SPF at that flow temperature 3.00 1.84

For conventional HPs, based on a weighted average stock calculation of W/m^2 per archetype (~75), the heat loss factor falls the higher end of our 50-80 W/m^2 band. This translate to a flow temperature of 45C. However, this is the temperature required for flow at peak. Thus, the flow throughout the year will be lower.

On the high temperature heat pumps, we had chosen 60C as what we thought would be the lowest temperature, while still allowing the standard oversize factor (1.3) and so not require radiator upgrades. However, revisiting the MCS emitter guide data, it seems that 65C is that minimum temperature. We will correct this.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 05 June 2020 16:48

To: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>&

Cc: [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&

Subject: RE: High temp HPs and flexibility in scenarios

Hi [Name redacted],

Please see our answers in-line below.

Looking into the costs, the calculation you performed is correct, but there is no error.

Because we need to have a method to allow for a flexible system size, the way we derived the marginal and fixed capex is based on the below linear relationship (see graph: x-axis is ASHP size in kW, y-axis is cost in £). From this, you can see that the line-of-best-fit does not exactly cross the points, but is representative of the relationship.

As such, the calculated marginal/fixed costs, and thus the method to calculate our HP costs, will not exactly match the raw assumptions log data points as we are using the linear relationship rather than the points themselves. However, the difference is practically negligible.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 05 June 2020 16:10

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: High temp HPs and flexibility in scenarios

Hi [Name redacted],

Just answering a few questions from central team to support their QA of buildings/power interactions. Might you be able to help with the highlighted in particular? We could give a different metric if needed but I was keen to reflect what sort of temps/efficiencies they are actually operating at in our scenarios.

I also wanted to flag that in trying to calculate the heat pump cost I realised that the marginal and fixed costs in 2020 (imply £7395 for 8kW system) given for ASHPs don't seem to match the 8kW cost (£7250)? Can we ensure all these costs are QA'd?

High temperature heat pumps

The model is finding these to be highly cost effective relative to other technologies such that we get high uptake where allowing them.

We define a high temperature heat pump as one that is operating at a designed temp. above 60c. They compare to conventional HPs as follows:

Conventional HP	High temperature heat pump
Average flow temperature assumed in home	
HW: 60C	
SH: Dependent based on heat loss factor of the archetype (~50C)	HW: 60C
SH: 60C	
Combined SPF at that flow temperature	2.54 2.10
Heat pump cost	£7024 for 7kW unit £7726 -
10% capex premium assumed (although likely would be cost equivalent in future)	
Additional costs	May need radiator upgrades costing between 1.1-2.6k
Does not need radiator upgrades	

You can find some discussion of them here:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/565248/Heat_Pumps_Combined_Summary_report_-_FINAL.pdf

Flexibility in the scenarios

I mentioned that I imagine our scenarios would be quite materially impacted if the cost reductions for flexible tariffs could not be realised. I think we have in the region of 5m homes in our central scenario accessing the highly flexible space heat price as well as the 5m on DH which use the highly flexible price, and around 6m homes accessing the flexible space heat price.

Thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 06 July 2020 15:44

To: '[Name redacted]'

Cc: '[Name redacted]'; '[Name redacted]'

Subject: RE: To do list and assumptions

Follow Up Flag: Follow up

Flag Status: Flagged

Hi [Name redacted],

Thanks for this. We have agreed to go ahead with the proposed amendment on bio in central (i.e. disallow in flats, terraced and semi-detached homes).

Understood on GSHPs. On that basis can we assume buffer tanks 50% of the time in all scenarios, and disallow ASHPs in social homes in Engaged people, Max and Widespread innovation? Grateful if you could let me know if you find any unintended consequences arise from doing so.

I've also had a query through from central team on our baseline that I am just looking into now; apparently we are slightly above the DUKES consumption estimates by 3TWh, I am just trying to establish if the discrepancy is in your baseline or the baselines I have been modelling. I will let you know as soon as I determine the source of the discrepancy here.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 06 July 2020 15:08

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: To do list and assumptions

Hi [Name redacted],

Please find our responses below.

Additionally, please do let us know the outcomes of the conversation with [Name redacted] when possible and your views on the numbers below. It would be good to get a confirmation on these items so that we can continue with the relevant input updates and QA.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 06 July 2020 10:31

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: To do list and assumptions

Hi [Name redacted],

I'm chatting to [Name redacted] at 2 so should be able to confirm after that on these points. A couple of further queries ahead of that:

- Would it be easy to assume again that all scenarios use buffer tanks 50% of the time (now that we know it is suppressing GSHP nos)?

o This is a relatively small cost (£150) so it would not have a huge affect by itself. That being said, it is relatively easy to add it to all scenarios.

- Do we have a sense of what the impact would be if we:

o Assume GSHPs suitable in 90% of homes in heritage scenarios, plus exclude ASHPs from SH

- Presume this will have a similar uptake as you mentioned, i.e. ~28% GSHP share

- Upon reviewing the model in more depth, the way the stock is split right now for the categories we have for heritage homes, we are unable to do 90% suitability in heritage for GSHPs (without a stock recalibration, which would take more significant effort). We can only do 75% (the case now) or 100%.

- In Engaged People, allowing GSHPs in 100% of listed homes would make them an option in a further 250k homes. However, as we have previously discussed, this may not be the most defensible option (i.e. due to innate geological constraints).

- As previously mentioned, disallowing ASHP from social homes would lead to a maximum of ~1.9M more GSHPs in that segment.

- The overlap between the above 2 segments is only 20k homes, so the above 2 changes in total could lead to a maximum of ~2.1M more GSHPs.

- The 2 changes would lead to the GSHP share rising from 18.8% to around 29%.

o Exclude high temp ASHPs/ASHPs from SH in innovation?

- Do you know what share of GSHPs we might expect?

- In Widespread Innovation, social homes uptake 2.6M ASHPs vs. 100k GSHPs. Disallowing ASHPs (including High T) could therefore lead to a maximum of 2.6M more GSHPs. These numbers do not include the 200k hydrogen hybrid ASHPs uptaken in social homes (these are forced in).

- If the maximum switched, 2.6M more GSHPs would lead to the GSHP share rising from 3.6% to about 17%.

o Exclude ASHPs from SH in Max?

- Do you know what share of GSHPs we might expect?

- In Max, social homes uptake 2.4M ASHPs vs. 90k GSHPs. Disallowing ASHPs could therefore lead to a maximum of 2.4M more GSHPs.

- If the maximum switched, 2.4M more GSHPs would lead to the GSHP share rising from 4.1% to about 19%.

The logic on the latter two is that GSHPs are generally more compatible with heat as a service, so it would make sense to assume some more uptake in max and innovation on that basis, and presume easiest to encourage through adjustment to buffer tank costs and adjustment to social homes?

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 03 July 2020 13:01

To: '[Name redacted]' <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>

Subject: RE: To do list and assumptions

Thanks [Name redacted], I think your proposed approaches are likely to be the ones to go with but I'd like to spend a bit more time thinking about it and to clear the bio point in particular with [Name redacted]. Do you need an answer today on this? I've got my head in some of the EE stuff so would prefer to get you an answer on Monday if that won't hold you up

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 03 July 2020 11:20

To: [Name redacted] <[Email address redacted]@theccc.org.uk> & [Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>

Subject: RE: To do list and assumptions

Hi [Name redacted],

Please see my in-line comments below.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk> [mailto:[Email address redacted]@theccc.org.uk];

Sent: 03 July 2020 07:59

To: [Name redacted] <[Email address redacted]@element-energy.co.uk> [mailto:[Email address redacted]@element-energy.co.uk];

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> [mailto:[Email address redacted]@element-energy.co.uk];
[Name redacted] <[Email address redacted]@element-energy.co.uk> [mailto:[Email address redacted]@element-energy.co.uk];

Subject: RE: To do list and assumptions

Hi [Name redacted],

Many thanks for this.

On GSHPs, did you identify why we have such a low % of GSHPs in max and widespread innovation (i.e. why are ASHPs proving so much more preferable in the max, and why do high T GSHPs not feature more in Widespread innovation)? I am keen to understand this before we make a final decision on which scenario to increase them in.

- This is likely being caused due to a set of different factors, as these scenarios have different assumptions to the others:

- o ASHP lifetimes are 17 yrs (1.13x the 15 yrs used in other scenarios) compared to GSHPs which are 22 yrs (1.1x the 20 yrs used in other scenarios).

- o No buffer costs are included (considering the buffer tanks are a fixed cost, this is a relatively larger % drop in capital cost for ASHPs than GSHPs).

- o Lower cost of EE measures favours lower efficiency LCH uptake (i.e. more cost effective to trade-off slightly higher operating cost for lower capital cost, favouring ASHPs over GSHPs).

In terms of your proposals, I think the social homes change is an option but I would still have a preference for driving through the cost change if we think it would work. Is it possible to predict (using levelised costs) or do a quick run to try it?

- It is not feasible to easily predict what will actually happen before running the scenario, as the modelling is sufficiently complex that many factors are in play. However, as an initial proxy, looking at the LCoH analysis we did, a 5% decrease in LCoH would still not make a GSHP variant lower than the equivalent ASHP variant. As such, it may be that this cost reduction is not sufficient.

- o If you do feel that this is the most favourable method to test, we could do a run with the 5% additional cost reduction, but unfortunately, there is no quick way to do so. We would have to make the relevant input changes, do the run, and summarise the outputs which would take ~2 hrs.

- The exclusion in social homes is more likely to achieve the desired result and, as previously discussed, it could be thought of as more aligned to this scenario narrative than the cost reduction.

- Let us know your thoughts here and we will proceed accordingly.

On BioLPG in central, is there a way to restrict it by only allowing in dwellings over a certain heat demand? If not we could at least remove from semi-detached as well, as a proxy for only allowing in the biggest properties – presumably that would take demand down to just over 5 TWh? Agree the additional GSHP cost savings doesn't really fit with the narrative. Remain interested in any other ideas you come up with on options here.

- We do not have the explicit ability to limit suitability by demand. As such, we can follow your suggested option above and could remove flat, terraced, and semi-detached (only allowing it in detached). This would likely drop the BioLPG use to just under 5 TWh.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 02 July 2020 19:21

To: [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>&

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&;
[Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&

Subject: RE: To do list and assumptions

Hi [Name redacted],

Thanks for sending these items through.

Regarding your question on timing, as an initial estimation, we are aiming to have the tasks (excluding sensitivities) completed and run by the 8th. After looking through the items in more detail with the team, we will have a better sense for the required effort for each of the tasks. As always, will keep you informed in case our currently estimated timeline changes for any reason.

On the GSHP tasks, we were hoping to get your view on the following options for Engaged People and Central.

Engaged People:

Goal & getting more GSHP uptake.

For Engaged People, it seems that much of the off-gas stock is actually uptaking ASHPs (~2.36M) rather than GSHPs (~681K) or BioLPG hybrids (~300K). As such, the BioLPG levers we discussed on our call (which may have applied to Central) likely will not apply here. It is also not clear that the currently allocated BioLPG hybrids would move to GSHPs over ASHPs.

In any case, the BioLPG hybrids in this scenario have minimal uptake and, as you mention in the modelling to-do list, & currently GSHPs make up 21% of all heat pumps in Central [and] 19% of all heat pumps in Engaged People&

Therefore, if the goal is to increase the proportion of GSHPs in Engaged People (to higher than the 21% currently seen in Central), we are going to need additional GSHP uptake in the order of millions. A heritage suitability change is insufficient here.

We suggest doing one of the following with the idea that each option would effectively ‘force’ other technologies to take the place of the incumbent ASHPs (with the presumption that the majority shift to GSHPs):

1) Disallow (make unsuitable) ASHPs in social homes. This would increase the GSHP share to a maximum of 28%, if all 1.9M are shifted.

2) Disallow ASHPs for off-gas grid dwellings. This would increase the GSHP share to a maximum of 30%, if all 2.4M are shifted.

Each of the above could be explained in the narrative differently (e.g. social homes favouring longer-term solutions with lower operating costs). Additionally, we could add back in the 5% additional cost savings here if we feel strongly that this is a good option.

Engaged People Uptake Heating system

Stock segment ASHP (exc. BioLPG hybrids) GSHP BioLPG hybrid HP

Social Homes 1,939,967 1,339,427 18,445

Off Gas Grid 2,357,297 680,799 306,061

Total Stock 16,869,252 3,971,265 306,061

Central:

Goal – reducing BioLPG uptake.

Currently, we have an uptake of 1.5M BioLPG hybrids which roughly equates to 7.8 TWh/yr fuel use. If the cap is being brought down (from 8.3) to ~4.2, we would need to effectively shift ~700K BioLPG hybrids. As it stands, the majority of BioLPG hybrids are being deployed in large, detached, owner occupied, off-gas dwellings (>750K); this is a segment which is appropriate for this technology type. Therefore, shifting this uptake without impacting our cost-effective modelling is a bit more complicated. As we mentioned before, we do not have the ability to ‘force down’ technologies.

In the first instance, if it is flexible, we suggest doing both of the following:

- * Disallow BioLPG hybrids in flats and terraced dwellings (~330K BioLPG hybrids or ~1.76 TWh).
- * Instead of dropping the BioLPG cap to ~4.2 (from 8.3), drop it to ~6.2 to allow for more uptake.

We have already increased the fixed cost (slightly) for BioLPG hybrids (based on the Delta EE update); ideally, that should also drop the uptake numbers. We could also account for an additional 5% additional cost savings for GSHPs (however, this option is not necessarily aligned with the scenario narrative).

We are still looking into other options here; however, we wanted to send you the above thoughts as a starting point. It would be good to get your views on the reasoning behind this halving and if you had any other methods you in mind to achieving it.

Central Uptake Heating system

Stock segment BioLPG hybrids

Flat 1,641

Terrace 327,211

Semi Detached 217,850

Detached 916,309

Total Stock 1,463,011

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: 02 July 2020 12:55

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Subject: To do list and assumptions

Hi all,

Please find attached an updated to do list following our meeting yesterday.
I've also attached an assumptions log with the following updates:

- New bio caps, as discussed these are somewhat flexible
- Some additional assumptions for the purposes of the bio £/t to be used in reporting
- Flexible LRVCs for use in a sensitivity
- Gas LRVCs for sensitivities (although these are deprioritised)

When you've had a chance to go through, good to understand what date you plan to aim for given final submissions need to be in on the 10th.

Many thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 17 July 2020 09:12

To: [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]

Subject: RE: £/t QA

Hi [Name redacted],

As a first step for the QA here, I've set out a list of things I'd be grateful if you could confirm to make sure we are aligned on approach to cost and optimisation calculations:

- Are you able to confirm that new measure £/t is calculated as per the guidance shared at the outset? (also reattached) I.e. that:
 - o £/tCo2e represents the net present cost of the measure, divided by the total discounted lifetime abatement where:
 - NUMERATOR: NPV cost of measure = stream of annual costs comprising the sum of the annualised capital cost plus in-year opex and energy costs (discounted using the NPV function with the 3.5% declining social discount rate)
 - DENOMINATOR: 'NPV' of abatement = stream of annual abatement discounted using the social discount rate
 - o That when the NPV function is used, the NPV calculation is undertaken for years 1+ and this is added to undiscounted values for year 0
 - o That costs are annualised using the PMT function (using a negative PMT, with Type set to 1, and using the 3.5% rate for domestic)
 - o That both direct and indirect emissions are included in the denominator

- Are you able to confirm that new measure £/t and average measure £/t have been calculated as per the worked example shared?
- Can you confirm what time horizon is being used for the NPV calculation for the purposes of calculating new measure and average measure £/t?
- Can you confirm that when average measure £/t in the templates for a given year is multiplied by total abatement in that year for that line item (direct and indirect), the result is the total costs incurred in that year?
- Am I right in thinking that for the purposes of defining which energy efficiency measures are economic for package formulation and technical potential, new measure £/t has been used? Was this calculated for 2030 or 2050?
- For the optimisation approach are you able to confirm the following:
 - o We are optimising on a lowest lifetime cost basis
 - o This uses the numerator for new measure £/t
 - Uses annualised capex which inherently reflects the lifetime of the measure applied (in line with use of PMT function specified above)
 - Uses the stream of fuel and maintenance costs
 - Calculates the present value using the NPV function (and as above the NPV calculation is undertaken for years 1+ and this is added to undiscounted values for year 0)
 - o As agreed for the optimisation, a uniform 20 year time horizon is used for the NPV (which avoids the need to divide by anything to put costs on a comparable basis)

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 16 July 2020 15:25

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: £/t QA

Hi [Name redacted],

As part of QA I am keen to check the calculation approach you have for both new and average £/t. Last time round (when we had a different definition) I know you sent a worked example for me to look at. Do you think a similar approach would be best this time round? I obviously sent you the worked example at the outset to work from, so just keen to verify that we are precisely aligning to this.

Many thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 27 July 2020 14:25

To: '[Name redacted]'

Cc: '[Name redacted]'; '[Name redacted]'

Subject: RE: End State Feedback Required

Follow Up Flag: Follow up

Flag Status: Flagged

Hi [Name redacted],

Steers from the meeting just now as follows:

- Please use the 11% EE level in headwinds (i.e. with EE uptake deemed more cost effective).
- Let's stick with the 12% EE level in central at this stage.

I have a meeting from 3-5 with the CITB but will aim to have a look at your email next [Name redacted].

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 27 July 2020 11:20

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: End State Feedback Required

Hi [Name redacted],

I did thank you and hope you all did too.

I left some outstanding qs on the baseline calibrations that we need to agree ahead of the runs – what time today are you aiming to get back on those points?

In relation to the sensitivities, thank you very much for doing them. I think there is a question about whether we hold the LCH mix constant for some of the final runs of these so that we are just showing the cost impact – is that a possibility? A few questions relating to the versions you sent:

- Hybrid heat pump operation – can you remind me how many hybrids were forced in the original central scenario?
- Increase in costs of flexible electricity – this seems to have led to a switch away from hybrids, with overall costs being roughly the same. Is this effectively caused by the benefits of hybrids in providing flexibility being reduced?
- Use of retail prices – Again we are seeing a switch away from hybrids – do we know why this might be? It is extremely odd that we seem to have substantially lower total costs, can this be right?

In relation to EE, I am aiming to confirm on these points aft my meeting at 1pm today, but my reactions so far are that:

- I suspect we will want to revert to the corrected headwinds uptake – the thing that I think is more uncertain is if we will want to change the EE uptake in central too
- Having been over your QA on NEED savings again, I think the key will be noting the uncertainties in the write up over the methodology.

More generally, for the chat later I am keen to give some more explanation to why overall % savings in heat demand are now half what they were for net zero. Am I right in thinking the following are the key factors, with the changes to economic potential being the one with most impact?

- Lower savings potential for 6CB for measures such as solid and cavity walls
- Significantly lower economic potential
 - o We now account for HTT, a proportion of which are not economic
 - o We have corrected the overestimate in potential for loft top ups which was substantial.

In terms of the timetable, I have yet to go through it end to end but will try to do so asap. I agree that the aim should be to tie down the scenarios so that the report can be produced on the basis of the final scenarios. I do need to flag

though that if an error is found over the coming weeks, we are likely to still need to correct it as we need to ensure anything we publish is error free. Sure you are aware of this but I thought worth mentioning.

One other point that I wanted to mention – when we last calculated economic potential and which EHTT homes to exclude I used your –EE Cost & Savings Cost Effective Analysis v5– to calculate the £/t of each of the HTT categories. I then excluded all HTT homes above £600/t. However, when I redo the analysis with the v7 of the file, the EHTT cavities now come in at under £600/t. I need to spend a bit more time looking at what has happened here.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 27 July 2020 08:26

To: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>&

Cc: [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&; [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>&

Subject: End State Feedback Required

Hi [Name redacted],

Hope you had a good weekend.

Just wanted to check-in with our plan for today. Considering that I am on annual leave from this Wednesday (to Friday), we are aiming to run our final end-states/trajectories later today (or tomorrow if necessary). Based on our noted actions and amendments, we are on track to do so. However, there are a couple of items which are awaiting your feedback, that we may need to incorporate prior to being able to run. It would be great if you could get back to us this morning (or as soon as you can) with the following:

- Feedback on Headwinds (and any further implications) regarding the level of EE uptake (believe you already have a meeting planned for today on this item).
- Sensitivity feedback (any amendments based on the end-states sent over on Friday that would affect our core scenario uptake/trajectories).
- Any additional feedback regarding EE corrections needed based on how NEED evidence is incorporated.

Please let us know the approximate timings for when you think you will be able to provide a steer the above.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk <[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0)>

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Element Energy Limited Registered in England and Wales Registered number
4646003

From: [Name redacted]

Sent: 28 July 2020 12:15

To: [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]

Subject: RE: Baseline calibration

Follow Up Flag: Follow up

Flag Status: Flagged

Hi [Name redacted],

We just chatted and I suggested you deprioritise the heat demand adjustment for heat sold in order to enable you to get on with the wider edits to produce the final scenarios. On this basis we will be allocating heat sold predominantly to gas, but we will not make an adjustment to account for the fact that heat sold (3TWh) is actually heat demand and not fuel demand.

Central team/[Name redacted] for visibility this means we'll be underestimating heat demand slightly (in the order of 2.3TWh out of 313TWh of total heating demand, or 0.7%). I imagine you will be comfortable but please do shout if you have any concerns with my deprioritisation here. The element team will be commencing the runs shortly today.

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 08 July 2020 14:43

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

We just chatted. We identified that there are two inaccuracies relating to how heat sold (3TWh in ECUK templates) is currently being treated in the work - please correct if wrong:

a) We are likely underestimating heat demand for the small number of homes using heat networks in the counterfactual. As per logic below, we agreed we didn't feel it would be prudent to make a change to correct this at this stage, as impacts likely limited, but the change would be very time consuming, risking our ability to deliver updated scenarios this week.

- In the model itself, all energy demand and emissions not relating to gas and electricity are bundled into an 'other' category for the counterfactual which gets a total TWh of fuel use and total emissions value. These are used to derive an averaged emissions intensity for the segment. A representative price is also used to reflect the mix (when you have time I'd be grateful for further detail on how this is derived).

- The TWh of fuel use for this 'other' category is then used to derive associated heat demand. This is done by accounting for the ECUK table S7 average stock boiler efficiency of 79.37%. We identified that for the heat sold segment this is inaccurate and we should be assuming a 100% efficiency given the ECUK nos actually reflect heat output.

- We expect this to lead us to underestimate heat demand slightly with our current methodology. However you explained that a change here would be onerous in terms of time, and would be unlikely to have a significant impact on the aggregate outputs. I also note that there is much broader uncertainty associated with the 79% assumption (based on 2012 data of limited accuracy) which we'll need to note in the write up anyway.

b) We are not reflecting TWh of fuel use in the template correctly. We agreed that there would be time to correct this, both allocating fuel use associated with heat sold to the right categories (mainly gas), and accounting for the efficiency of heat networks. NB this will mean starting values for all fuels will differ further from published values; we need to explain the factors causing this in the write up.

Mike; we chatted a bit earlier, I wasn't aware of point a) at the time so we didn't cover this; please let us know asap if you have any concerns with the above approach. Element are beginning to commence runs now so that we are able to deliver them in time.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 08 July 2020 13:45

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Hi [Name redacted],

We calculate the average emission intensity based on the total fuel consumption of 'Other' category. It is possible to account for the conversion efficiency by having those combined in the 'Other' category breakdown such that it adds up to more than 100% due to the DH energy centre thermal efficiency i.e. when the 'Other' fuel is mapped back to oil/solid/biomass/gas the TWh are higher due to the heat sold fuel use to heat delivered difference. What efficiency factor do you want to use if we apply this approach to heat sold TWh?

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>

Sent: 08 July 2020 12:59

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

You can see the split of input fuel in row 19 of DUKES 1.1 as per Liz's email <https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes>. I think it will still be inaccurate in as far as the TWh of heat sold is not equivalent to the TWh fuel inputs of the respective fuels. However, my understanding is that this remains an issue in any event and that the modelling itself will bundle heat sold into the 'other' category where the total TWh and total emissions are used to derive the average emissions intensity for that segment?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 08 July 2020 12:45

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

Yes, we can further split the heat sold into gas, biomass, electricity etc such that this is then reflected in the final split of 'Other' fuel category and used in the scenario template population. If we only want to assign 90% of heat sold to gas, what should be the breakdown of the remaining 10%?

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Sent: 08 July 2020 11:55

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

Thanks yes I can see the benefit of keeping it in the 'other category' for the modelling, and then just refining the reporting of it in the templates. When you say 'we can further split heat sold into gas and non-gas fuels', can we put all or 90% of it in gas in the templates given this is what the data shows on fuel inputs? I note that heat sold is heat output, as distinct from fuel input so isn't directly equivalent to gas use.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 08 July 2020 11:48

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Hi [Name redacted],

The alternative approach would keep 'heat sold' fuel consumption in the 'other' fuel category and therefore be used to calibrate the total Oil + Community counterfactual fuel use as done currently. We calculate the resulting average CO2 content of this combined category so that the baseline emissions are also aligned, but in the step of scenario template population split the 'Other' category back into the various fuel components. We can further split heat sold into gas and non gas fuels, the final input to the model is the collective breakdown of all the non gas and electric fuel consumption that the 'Other' category represents. This approach is the most consistent representation of the counterfactual heating systems, as otherwise combining it with gas would lead to increase in gas boiler archetype demand when it is in fact the community counterfactual.

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>

Sent: 08 July 2020 11:13

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

I have now got an answer back from BEIS confirming that gas represents around 90% of fuel input for heat sold. I think ideally TWh consumption would be recorded as gas on that basis.

I am not sure I am fully following the below but are you saying here there is an option to treat 'heat sold' as other in the modelling, but allocate the TWh consumption to the gas category in the templates? Could it be allocated to the gas category only, and not the other fuels?

Helpful to also understand the downside to this approach, is it just that it would be more time consuming than the alternative?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 08 July 2020 10:46

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

Allocating the heat sold to gas would result in more emissions from gas consumption, which would require the CO₂ content of 'other' fuel category to be re calculated to align with baseline emissions. This will have impacts on the heating demand calibration as that is related to total stock fuel consumption. Alternatively, we can keep the assignment of heat sold to other and assign it as gas in its breakdown in addition to oil/solid and biomass, this should keep the fuel emissions the same but show the 'heat sold' component of 'other' category as gas in the final scenario template outputs. The current fuel content and split for other category is as follows:

Temperature adjusted emissions (Mt CO ₂)	69.661
Emissions to be removed (Mt CO ₂)	1.716
Net emissions (Mt CO ₂)	67.945
Gas emissions (MT CO ₂)	59.622
'Other' fuel emissions (MT CO ₂)	8.323
'Other' fuel use (TWh)	65.757
'Other' fuel CO ₂ (kg/kWh)	0.127

other fuel BREAKDOWN OIL 45%

BIOMASS/HEAT SOLD 45%

SOLID 10%

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 08 July 2020 10:12

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi all,

Is anyone able to help with the below question? Conscious you need an answer on heat sold allocation asap.

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 08 July 2020 09:32

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

I forgot to add on the email this morning, an answer to the highlighted would still be helpful to help us take a view.

Thanks very much,

[Name redacted]

From: [Name redacted]

Sent: 07 July 2020 18:42

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Subject: RE: Baseline calibration

Hi [Name redacted],

I have already completed a further round of QA on the baseline and have some small edits to suggest on the emissions and fuel consumption – the point I still haven't managed to pin down a steer on, is where to allocate heat sold, and specifically whether it should be spread across petroleum/solid/bio or whether it should be allocated to gas on the basis I understand most heat networks to be gas CHP.

Would it be helpful if I send through the nos from my QA now, with the heat sold point outstanding? Can I also check, if we were to move heat sold into the gas category, would that create a problem in that the emissions, fuel use, and average efficiency would no longer match?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 July 2020 18:36

To: [Name redacted] <[Email address redacted]@theccc.org.uk><mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk><mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk><mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

Thanks for the update on this.

We just wanted to follow-up to see if there are indeed any changes that need to be accounted for. Ideally, we would like to have all the changes (that affect end-states) finalised by tomorrow morning so that we can aim to run the updated scenario end-states and QA as necessary.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk><mailto:[Email address redacted]@theccc.org.uk>>

Sent: 07 July 2020 08:23

To: [Name redacted] <[Email address redacted]@element-energy.co.uk><mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk><mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk><mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi all,

Following central team's query I have now done the follow up QA of the baseline numbers and will have a few small edits to request. I am just trying to clear the approach with central team before sending over, I hope that is ok.

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 18 June 2020 15:47

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Hi [Name redacted],

I suspect I will need to do a fuller QA of the baseline next week but from a very high level check the below doesn't look unreasonable. Oil ems intensity in our assumptions is 246, other is roughly half bio and half oil, and bio is counted as 0 CO₂ in the inventory (and our assumptions), so 0.127 sounds in the right ballpark.

Given the runs still haven't commenced, I'd be grateful for an update on when you expect to complete them in relation to the deadlines? I also don't think I've had the widespread innovation results through yet?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 18 June 2020 15:09

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

Using the temperature adjusted emissions gives the following CO2 content for ‘other’ fuel category.

Temperature adjusted emissions (Mt CO2)	69.661
Emissions to be removed (Mt CO2)	1.716
Net emissions (Mt CO2)	67.945
Gas emissions (MT CO2)	59.622
"Other" fuel emissions (MT CO2)	8.323
"Other" fuel use (TWh)	65.757
"Other" fuel CO2 (kg/kWh)	0.127

Best regards

[Name redacted]

Principal Consultant

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 18 June 2020 14:54

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Thanks [Name redacted], our numbers aren't exactly the same but round to the same figure 68MtCO₂. If you have time to make them match exactly I would try taking the temperature adjusted emissions from D67 on tab 'Temperature adj. emissions'; from the 'Temperature adjustment'; file, and subtracting the following:

SourceName	ActivityName	CCC sector	2018
Cooking			1.31716
House and garden machinery	DERV	Domestic buildings	0.03373
House and garden machinery	Petrol	Domestic buildings	0.34115
Non-aerosol products - household products buildings		Petroleum waxes Domestic buildings	0.02386

That should align with our view of carbon emissions for heat and hot water in 2018. Not high priority at this point though so fine to leave as is for now if that complicates things.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 18 June 2020 14:24

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

As mentioned over the call, I have attached the file with baseline emissions reference. This is defined in the sheet 'Ems for EE baseline' in cell AE36 for direct CO2 emissions.

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 18 June 2020 11:56

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Thanks [Name redacted], the first table looks about right (some differences in the 3rd decimal place but minimal).

How have you got to the Mt in the second table, is it using our emissions factors or some other approach?

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 18 June 2020 11:39

To: [Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Hi [Name redacted],

I have summarised below the revised baseline consumption by aggregating the non gas/electric categories since there is not a direct mapping in ECUK and we represent them collectively as a single fuel cost and CO2 based on the share. This gives the following fuel breakdown:

Heating system	Efficiency	Fuel demand – ECUK (TWh)	Fuel demand – temperature adjusted (TWh)	Final heating demand (TWh)	Direct emissions(Mt CO2)
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Gas boiler	79.40%	309.170	324.723	257.830	59.622
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Electric	100%	22.889	23.934	23.934	
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Other 79.40% 63.988 65.757 52.211 7.933

Total 396.048 414.414 333.975 67.555

The gas and electricity values are same as before. Gas increases by 15.533 TWh, electricity by 1.045 TWh and other by 1.768TWh. The average cost and CO2 of other category is based on the following breakdown:

DOMESTIC BUILDINGS (MT CO2) 64.67

GAS – Non temperature adjusted (MT CO2) 56.77

REMAINING EMISSION (MT CO2) 7.90

OTHER FUEL (OIL+COMMUNITY) - TWH 63.99

AVERAGE CO2 CONTENT (KG CO2/KWH) 0.123

other fuel BREAKDOWN OIL 45%

BIOMASS/HEAT SOLD 45%

SOLID 10%

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>[Email address redacted]@theccc.org.uk>>

Sent: 18 June 2020 10:42

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi all,

Just wondering whether you were able to resolve this and where we are at with commencing the runs?

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 17 June 2020 18:54

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Baseline calibration

Hi [Name redacted],

In relation to the ECUK figures, I can't currently reconcile them:

Gas and electric match ECUK. We then have:

- 28.81 TWh of oil in ECUK

- 6.11 TWh of solid fuel in ECUK
- 3.03 TWh of heat sold in ECUK
- 27.55 TWh of bioenergy and waste in ECUK but as per previous email only 26.04 TWh should be included here (this aligns with DUKES/what is in cells D17:D21 of the prices for modelling workbook)

The total should equal 396.05, I don't think the DUKES adjustment has been accounted for in your nos?

I am also not following the category groupings. Oil boiler seems to include oil and bio, and community seems to include heat and solid. What is the logic for this? Are we also able to amend the labelling so that it is clearer? See my email of 11th of [Name redacted] for thoughts on this at the time.

The temp adjustment stage should add 18.366 in total, it looks to be adding 18.38. Whilst the right amount has been added to gas, it doesn't look like the right amount has been added to electricity (0.62 has been added when it should be 1.05). There is then 1.77 that then needs to be added to other.

On the final heat demand, the simplified/old assumptions on efficiencies are likely to add inaccuracy but I don't know of a better source of data here. [Name redacted], copying you in in case you know of anything on your return.

Are direct emissions then calculated using our assumptions on emissions intensity based on the fuels? How do we work out the intensities where categories are combined? At a high level the emissions look sensible.

In terms of steers on other items the decision was not to include bio indirect emissions in the modelling. Note that we will likely need to make an adjustment to the templates later in respect of this.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 17 June 2020 17:33

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email Address redacted]@theccc.org.uk<mailto:[Email Address redacted]@theccc.org.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

The climate adjustment to 2030 is only applied to space heating. Please can you confirm the following fuel use and resulting heating demand for baseline calibration:

Heating system	Efficiency	fuel demand – ECUK (TWh)	fuel demand – temperature adjusted (TWh)	FINAL heating demand (TWh)	DIRECT EMISSIONS (MT CO2)
----------------	------------	--------------------------------	--	----------------------------	---------------------------

Gas boiler	79.40%	309.17	324.72	257.83	59.62
------------	--------	--------	--------	--------	-------

Oil boiler	79.40%	56.36	57.88	45.96	6.98
------------	--------	-------	-------	-------	------

Electric resistive	100%	8.12	8.49	8.49	
--------------------	------	------	------	------	--

Electric storage	100%	14.77	15.44	15.44	
------------------	------	-------	-------	-------	--

Community	79.40%	9.14	9.39	7.45	1.13
-----------	--------	------	------	------	------

Total		397.55	415.93	335.18	67.74
-------	--	--------	--------	--------	-------

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 17 June 2020 14:23

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email Address redacted]@theccc.org.uk>
<mailto:[Email Address redacted]@theccc.org.uk>

Subject: RE: Baseline calibration

Hi [Name redacted],

I think the best thing to do would be to apply the increment from the temperature adjustment directly to the actual demand, rather than using a % scaling. This is also more in line with how we calculate it for CCC progress reports.

Unhelpfully, the figure to use for the increment is not obvious because cell H24 of table C5 does not match the space and water heating demand in the ECUK end use figures. Can we instead use the attached which are based on a more detailed (unpublished) temperature adjustment breakdown from BEIS – grateful if you could avoid sharing/using more widely.

The key figures to look at are row 64 of tab ‘annual energy consumption’. There is a +18 TWh temp adjustment and it shows how this is split across gas, electricity and other in the domestic sector. You will see that by our calculations this has adds 3.3 Mt of direct emissions in total. I am interested to see what total residential emissions this gets you to for 2018. The figure of 69.7 Mt in the attached (‘Temperature adj. emissions’ tab, cell D67) includes cooking as well, so I don’t expect them to be exactly aligned but good to know how far off they are.

More generally I think it is safest to assume that the temperature adjustment is all added to the space heat demand rather than the hot water demand.

Have you also applied the warming climate adjustment such that it only affects the space heat demand and not the hot water demand?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 17 June 2020 12:10

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

I have summarised below the data from ECUK. Applying the temperature correction only to space heating leads to a correction factor of 6%.

Table C5, Domestic Table U3, Domestic

Final Consumption domestic	Temperature corrected	Change	Space heating	Water	Total
	Temperature corrected	Space heating adjustment factor			

479.73	498.52	103.9%	315.68	81.87	486.91	505.98	106.0%
--------	--------	--------	--------	-------	--------	--------	--------

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 15 June 2020 16:41

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Thanks [Name redacted] (and apologies if you had mentioned table S7 before – I had looked through previous emails but didn’t manage to spot the source). I suspect that the climate adjustment may relate to the space heating component only but I am not totally confident of this. I have gone back to BEIS to ask if they have temp adjusted figures broken down by end use that might help.

How quickly do we need to make a decision on this bearing in mind the timelines, and am I right in thinking it would impact £/ts etc to some degree? If we don’t get a response from BEIS I am wondering if it would be better to revert to the HDD approach. How did we apply this for net zero, and was it applied to the space heat component only or all space heat and water consumption?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 15 June 2020 16:05

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Baseline calibration

Hi [Name redacted],

The stock average boiler efficiency is based on Table S7. Regarding the climate adjustment, space heating and hot water demand make up 82% of total domestic fuel use, if we assume all of the climate adjustment is in those two categories then the adjustment factor increases from 3.9% to 4.8%.

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 15 June 2020 15:37

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Baseline calibration

Hi [Name redacted],

Thanks for this. Looking at the sources, the 3.9% weather adjustment seems to be applicable to total domestic consumption which will include cooking and lighting and appliances too. I think this means that the 3.9% is unlikely to be directly applicable to space heat and hot water – it would presumably underestimate the temperature adjustment for those segments specifically?

Separately, helpful to understand how you derived the 79.4% efficiency?

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 15 June 2020 13:37

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: Baseline calibration

Hi [Name redacted],

The email below describes the approach for the baseline calibration. The original data sources are as follows:

1. 2019_End_use_tables_2 – Total space and hot water fuel use in Table U3, 397TWh in 2018

2. 2019_Consumption_tables_2 – Temperature corrected fuel use in domestic sector in Table C5, 3.9% in 2018 leading to 413TWh fuel demand

3. Applying the baseline stock efficiency gives heating demand of 332 TWh

4. Additional climate adjustment to 2030 reduces it to 313TWh

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 12 March 2020 16:08

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Prices for modelling

Hi [Name redacted],

I have revised the baseline heating demand taking into account the suggested changes of mapping solid to oil as well as applying a final calibration factor for temperature adjustment. Looking at ECUK Final energy consumption Table C5, the temperature adjustment factor that I get for domestic fuel use is 3.9%. The resulting fuel use and emissions are as follows:

Heating system Stock Efficiency fuel demand – ECUK (TWh)
TEMPERATURE ADJUSTED FUEL DEMAND (TWH) FINAL heating demand (TWh)
DIRECT EMISSIONS (MT CO2)

Gas boiler 23,285,970 79.4% 309.17 321.28 255.10 58.99

Oil boiler 2,007,240 79.4% 56.36 64.91 51.54 7.83

Electric resistive 658,387 100% 8.12 8.43 8.43

Electric storage 1,734,855 100% 14.77 15.35 15.35

Community 617,576 79.4% 9.14 3.15 2.50 0.38

Total 28,304,027 397.55 413.13 332.92 67.2

DOMESTIC BUILDINGS (MT CO2) 64.67

GAS (MT CO2) 56.77

REMAINING EMISSION (MT CO2) 7.90

OTHER FUEL (OIL+COMMUNITY) - TWH 65.49

AVERAGE CO2 CONTENT (KG CO2/KWH) 0.121

other fuel BREAKDOWN OIL 46%

BIOMASS 44%

SOLID 10%

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: 11 March 2020 09:37

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>

Subject: RE: Prices for modelling

Hi [Name redacted],

Thank you for this. I understand that the baseline we have now has a total fuel demand which matches ECUK, and emissions which match the final emissions data I shared with you. My understanding is that the issue we had last time with emissions being overestimated is therefore now corrected, is that right?

My understanding is that the key simplifications and therefore potential sources of inaccuracy are around how non-gas/electric/oil systems have been treated. A couple of questions on this:

- What is the reason for mapping solid to community rather than oil? I imagine the main thing here will be mapping heating systems with others which most closely share characteristics in terms of the nature of the retrofit which will be required (e.g. whether need hot water tank etc)
- Do we need to call it 'oil' or could we call it 'other' to be more accurate (viable if solid moved into that category too)?
- When we calculate the counterfactual costs we will need to develop a blended LRVC for the non-gas/elec heating systems based on the proportions of the different fuels in the mix. I think you have the information to do this from the prices sheets I sent through but please let me know if you need anything more from me on this.

In terms of the average CO2 content for oil and biomass, 120gCO2/kWh looks broadly consistent with what I get if I average the carbon intensities for these fuels from our prices workbook.

You asked a separate question which I understand to be related to temperature adjustment. I think it does make sense to use temperature adjusted ECUK data for the final calibration step. I note your previous approach used a 38 year average HDD of 2135 vs 2017 HDD of 1889. I believe there are temperature corrected ECUK figures so is it possible to use them instead?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 10 [Name redacted] 2020 14:29

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>>

Subject: RE: Prices for modelling

Hi [Name redacted],

I have now completed the full stock fuel and emission calibration and wanted to share the outputs to ensure we are aligned.

1. Using the EPC output to calculate the heating demand, I get a total fuel consumption of 538 TWh
2. Using BEIS NEED outputs, I have derived calibration factors based on property type, size, wall and loft; this results in an average calibration factor of 64% reducing the fuel demand to 346TWh

3. Based on the ECUK data shared, the total fuel consumption in 2018 was 398 TWh, this results in low calibration factors for electricity and gas (1% and 8% respectively), while remaining heating fuel categories have an adjustment factor of ~ 60% - 70% (due to biomass and solid being added to oil and community categories respectively)

4. I have also calculated the weighted average CO2 content for these other categories by subtracting the gas emissions from the total domestic heating emissions

I have summarised these outputs below:

Heating system	Stock	Efficiency	fuel demand – EPC (TWh)	fuel demand – NEED (TWh)	fuel demand – ECUK (TWh)	Total heating demand (TWh)
----------------	-------	------------	-------------------------------	--------------------------------	--------------------------------	----------------------------

Gas boiler	23,285,970	79.4%	443.20	285.02	309.17	245.48
------------	------------	-------	--------	--------	--------	--------

Oil boiler	2,007,240	79.4%	51.92	33.25	56.36	44.75
------------	-----------	-------	-------	-------	-------	-------

Electric resistive	658,387	100%	12.59	8.07	8.12	8.12
--------------------	---------	------	-------	------	------	------

Electric storage	1,734,855	100%	22.42	14.69	14.77	14.77
------------------	-----------	------	-------	-------	-------	-------

Community	617,576	79.4%	8.26	5.66	9.14	7.26
-----------	---------	-------	------	------	------	------

Total	28,304,027		538.40	346.69	397.55	320.37
-------	------------	--	--------	--------	--------	--------

Fuel	Consumption (twh)	mapped heating system
------	-------------------	-----------------------

Gas	309.17	Gas boiler
-----	--------	------------

Electric	22.89	Electric resistive + Electric storage
----------	-------	---------------------------------------

Oil	28.81	Oil boiler
-----	-------	------------

Heat sold	3.03	Community
-----------	------	-----------

Biomass	27.55	Oil boiler
---------	-------	------------

Solid	6.11	Community
-------	------	-----------

Total	397.55	
-------	--------	--

Fuel	need (twh)	ecuk (twh)	calibration factor
------	------------	------------	--------------------

Gas	285.02	309.17	8%
-----	--------	--------	----

Electric	22.76	22.89	1%
----------	-------	-------	----

Oil 33.25 56.36 70%

Community 5.66 9.14 61%

total 346.69 397.55

Domestic buildings (Mt co2)	64.67
Gas (Mt co2)	56.77
Remaining emission (Mt co2)	7.90
Other fuel (oil+community) - twh	65.49
Average CO2 content (kg co2/kwh)	0.12

Best regards

[Name redacted]

Principal Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk

Sent: 10 March 2020 12:31

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

Subject: RE: Prices for modelling

Hi [Name redacted],

Responses below. Aside from modelling the baseline, can I also ask you to think today about any other input you might need from [Name redacted]? We need to make sure we are asking all of the questions we need input on now.

[Name redacted] and Mike – for your info it looks like we’ll need to deprioritise regional differentiation of network costs – [Name redacted], [Name redacted], [Name redacted], presume we could always come back to this for the regional bolt on task if we have ENA numbers by then?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 09 March 2020 16:33

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Prices for modelling

Hi [Name redacted],

Thanks for your email and the updated prices workbook.

Regarding your notes on the distribution/network costs and the other information we still require to run the baseline, please see the following; specifically underlined items are those that we need your input on:

* Network costs

* The current option is to use the Imperial/Vivid figures.

* However, following our conversation at the ENA last week, there is a possibility that they may be able to provide some data for this (currently following up). The group present at the ENA discussion were of the (strong) view that the regional variation of the costs in the Imperial/Vivid dataset were likely to be spurious, given the importance of other factors that we not accounted for in that analysis (such as the existing amount of headroom and other detailed/specific factors).

* Based on this, the suggestion (for your consideration), in the absence of further data from the ENA group, is to use a uniform £/kW figure from the Imperial/Vivid analysis without the regional variation. What are your thoughts on this? I think that sounds like the only viable approach at this stage. To be clear, my understanding is that it means reverting to the ‘prices for modelling’ tab, rather than performing a further adjustment to the ‘no D’ numbers I had generated?

* List of biofuels

* As part of our baseline, the biofuels will be combined with the category of oil; we will calculate a blended cost and CO₂e/kWh based on the total emissions breakdown (CO₂e for the stock, as requested below).

* For example, EHS has a ‘solid’ heating fuel category (0.6%) which is currently combined with oil to account for 4.5% of stock. We can define a weighted average cost and CO₂e of oil to match baseline fuel and emissions.

* OK

* Other information

* Total emissions CO₂e for stock and, if possible/available, breakdown by fuel type for the baseline (2019). Please find attached, first tab of ‘final 2018 emissions’

* Updated emissions projection breakdown by fuel type (i.e. breakdown into CO₂, CH₄, and N₂O in CO₂e); the Prices Workbook only seems to have CO₂. In order to derive emissions for the different gases please use the factors in the ‘conversion factor’ tab of the attached ‘final 2018 emissions’ spreadsheet

* Any further thoughts on the breakdown of the outputs for the scenario template.

* What will be the segmentation of the stock across the rows? I have attached some guidance (‘CB6 scenario template’), let me know if you have further qs.

* What cost elements are included in investment? (i.e. is it only annualised capex? Or, should it also account for opex and fuel cost
Investment costs should represent in year capital expenditure. They should be point estimates of the money out of the door in each given year;
therefore not annualised and should not include the cost of capital or any opex or fuel costs.

* Other input for scenarios; these are next on my list after doing some urgent energy efficiency related work this afternoon.

* Updated feedback on the list of technology configurations (from the Flexibility Configurations v6.xlsx; file sent to you last Wednesday).

* Set of behavioural measures to be included in the baseline (from the Behavioural Measures by Scenario.xlsx; file sent to you last Thursday).

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 09 March 2020 10:09

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: Prices for modelling

Dear all,

Please find attached prices to use for modelling.

The tab 'Prices for modelling'; no D; is the one where distribution costs are removed, so I understand this to be the main set you will be using? Can you remind me where we are at with the plan for how distribution costs are being added back in? Am I right in thinking we will be using the disaggregation consistent with the Vivid work<<https://www.theccc.org.uk/publication/accelerated-electrification-and-the-gb-electricity-system/>>? Please also note that whilst I have removed the distribution costs from the LRVCs and retail prices in this tab, they are still a component in deriving the variation between the flexible/less flexible price categories. I don't think this is a problem if we are using a disaggregation consistent with the Vivid work anyway.

In the attached you will also find caps on use and bio costs and emissions to use in all scenarios. These will all change further but I wanted to get the prices over to you now to enable runs of the baseline and so you can see the format the caps will take.

We actually have LRVCs and emissions for a wide range of biofuels. What is the set of biofuels you will be modelling for the baseline? I can then make sure I am giving you all the relevant LRVCs and emissions intensities.

Can you please also confirm what other information is outstanding to allow the baselines to be run? The only thing I am aware of is the proposal for how to account for warming in the scenarios; grateful if you could respond to the attached as soon as you are able today so that I can confirm a set of numbers to use here.

Many thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 28 July 2020 22:16

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]

Subject: RE: GWP issue

Hi [Name redacted],

Many thanks for the discussion earlier. You felt that making the AR5 correction for the runs would be manageable – this is much appreciated.

Please find attached an updated set of baseline emissions to calibrate to (row 19).

You will also see at the bottom my sense check against the fuel nos you are using. I think there are slight discrepancies as no heat sold is allocated to solid fuel so valuable to correct at the same time if straightforward.

We discussed why the CH₄ emissions were underestimated in the last run and you suggested it was a result of a simplified assumption on the relative CO₂/CH₄ emissions intensity, based on dominant fuel types. As discussed, grateful if the modelling could be adjusted such that we are aligning to the corrected CH₄ figures here that more accurately represent mix of fuels.

I flagged that central team had also identified an error in their biomass CH₄ intensity assumptions in the prices for modelling sheet. You mentioned that you didn't think this was used (given we calibrate the baseline to the inventory and we don't deploy biomass), and that it should therefore have no impact. I've

included the updated nos in rows 40 and 60 of the attached assumptions workbook nonetheless. At the same time they also made very slight tweaks to LRVC and emissions (rows 31, 55, 61 of the attached prices workbook). It shouldn't make much difference due to the magnitude but if possible grateful if we could update these for completeness.

Finally a query has been raised about the volume of hydrogen consumption in headwinds in 2025 looking quite high at 3.6 TWh. This would seem to imply about 1% of on gas homes are using hydrogen at that point but from the industry cluster stock workbook it looks like it should be 0.01%, is it possible to check this?

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 28 July 2020 16:23

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: GWP issue

Dear all,

Unfortunately an issue has been spotted in that the emissions baseline I shared to calibrate to is in AR4 GWPs whilst we should be using AR5 GWPs to model. Many apologies for this only being identified now.

The impact is a slight underestimate in CH₄ emissions (other gases are unaffected), i.e. we are currently using values based on the GWP of 25 when it should be 34 (see the GWP tab in the attached).

I am just trying to establish with central team whether this will require reruns or whether we can find another way round it and will try to update you asap. Very sorry for inconvenience caused here and happy to discuss if needed ([Phone number redacted]).

Thanks,

[Name redacted]

<< File: 6CB economy-wide assumptions 2019 v2.xlsx >>

[Annex E]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 31 July 2020 18:34

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]

Subject: Overheating adaptation measures

Attachments: BBSA Shading Costs for CCC.XLSX

Hi all,

[Name redacted] has managed to get the attached costs from the blinds and shutters association (thanks [Name redacted]!) and has suggested that we should:

..... cost up blinds in all properties ; with a range from the low spec blind to the high spec blind outlined in the excel sheet.

..... Add costs for external shading in the high rise flat ; separate costs for each of the different types of shading in the excel sheet

..... Include [Name redacted]'s proposed costs for ventilation in kitchen and bathroom (which should help with indoor air quality).

Element team ; if you are able to do this, [Name redacted] and [Name redacted] can then take a look and work out what ranges are appropriate for including in the report. If any further queries about properties to apply in [Name redacted] should be able to help.

[Name redacted] ; we still need to find a way to estimate how many homes might need MVHR and under what circumstances, was this something you were still planning to take a view on with [Name redacted] or do you think she is unlikely to have a view? If so I could try [Name redacted]?

Element team: In relation to the blinds and shutters some further info from [Name redacted] at BBS in case useful:

costed for:

..... 3 different types of Internal Shading - These are split into Low and High specification fabrics (the high specification has an improved gtot, i.e. the total solar transmission value of the fabric and glass, these fabrics typically have a reflective coating on the back) and a High spec shading installed with a frame that is attached to the window. The latter allows for effective ventilation with shading as well as the improvement of the frame.

..... 5 types of External Shading ; Roller Screens with Side Guides, Roller Screens with a Zip Guide, Venetian Blinds, Roller Shutters, Awnings and a Markisolette (also referred to as a sliding arm awning). All options have been costed to include motorisation which we think is best to include as the baseline cost to ensure they are used.

It may be useful to know that External Roller Screens with a Zip are more sealed/ airtight than Rollers with Side Guides. Therefore they prevent heat being lost in winter more effectively.

Concerning awnings, the most common size sold is a 3.6m x 2m extension which is frequently used to cover patio doors etc. We have cost for 1 awning in the attached for two different sized windows a 3.6 x 2.7m drop and a 5m x 2.7m drop. Awnings have a high cost because they need to be durable enough to withstand external weather conditions and therefore are more robust in terms of materials as they protrude from the external wall. Whilst they have a high cost they also offer a larger range of benefits e.g. they provide a protected outside areas for occupants which is also important to the health and well-being of occupants. Markisolettes are a more cost-effective option for smaller sized windows. These also drop down and then extend outwards and will allow windows to be fully opened.

On pg 2 of the Excel I have included some images of the products and attached are some graphics and explanations of the products from the REHVA Guide on Solar Shading which may be useful

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 13 August 2020 07:07

To: '[Name redacted]'; '[Name redacted]'; '[Name redacted]'

Subject: FW: Prices of bioLPG and biomass

Follow Up Flag: Follow up

Flag Status: Flagged

Hi all,

This is the email summarising the suggested approach for bio prices.

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 11 August 2020 09:37

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: Prices of bioLPG and biomass

Hi [Name redacted]

[Name redacted] needs prices of bioLPG and biomass for her bills analysis (not the templates). The Prices Workbook currently only gives "costs" of these vectors.

- The biomass "costs" are already approximately equal to prices, as the data are the imported biomass prices, and intra-country traded biomass prices (both without VAT at 5%, given the international dataset). It's too late to try and strip off margins (~5%), and get back to underlying costs, to re-run all the different modelling. Can you confirm you're ok with this cost = price approach? (In reality, true prices might be 5% higher, and true costs 5% lower.)
- The bioLPG "costs" are the production costs, ex-factory gate, using the biomass "costs" above, plus plant capex & opex. Downstream distribution costs are not considered, as these are the same as the fossil counterfactual (and would be counted within the transport sector). Fossil LPG is not given in the Prices Workbook, so I don't have a like-for-like comparison to scale between costs and prices. The nearest proxy is residential heating oil, from which the Greenbook has a consistent 15% uplift from costs to prices (no further info provided as to what this covers). Can you confirm it's OK [Name redacted] uses this 15% uplift in going from bioLPG "costs" to bioLPG prices?

Best regards

[Name redacted]

[Name redacted]

Senior Analyst

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Phone Number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 13 August 2020 14:41

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]

Subject: RE: Timelines & QA Log

Follow Up Flag: Follow up

Flag Status: Flagged

Hi all,

Thanks for the responses on the below, I was able to get them into the discussion in time. We had a productive session and the senior team gave some really positive feedback on how the scenarios have evolved so well done for all the work on them. Summary of where we got to below:

High priority items which do meet the bar for further change

- Unfortunately we think a change will be needed to the district heat representation, as the trajectory looks implausible and it will impact where we set the 6th carbon budget
- We talked about how to make a change in a low resource way, and came up with the following strawman suggestion (to be confirmed pending views):

- o Alter through off model adjustment (ideally set up so we can tweak further later if we need to)
- o Retain the deployment rates (pending confirmation, as I am just seeing if I can get hold of any projected deployment rates from BEIS)
- o Adjust so that pre 2025 the networks going in are gas CHP
- o Assume that from 2025 the networks going in are either decarbonised or in the headwinds case are 'hydrogen ready';
- o Assume that all of the heat networks up to 2025 are retrofitted by 2040
- I'd be grateful for your thoughts today if possible on the feasibility of an off model adjustment of the type described above (or whether you think an alternative approach would be preferable) [Name redacted] is off on leave next week and I'd like to get an approach agreed here before she heads off

Things which are not quite right but which we can live with

- FP EE trajectory is tricky, because the ramp up is so steep alongside the fact we have high packages for all these homes. We felt that it could be left as is on the basis that the EE in these homes shouldn't have a large impact on the overall budget not given the limited EE savings, and given that we want to be able to talk to the principles of having more EE in fuel poor homes and doing them early in line with gov't's commitment. However, it will need to be carefully framed in the write up (also to note that we are not actually recommending all FP homes have every EE measure, this was more about using an blunt model lever to put SWI in all FP homes)
- The off gas modelling remains more simplified than would be ideal, but again we think we can manage through the write up.

Further questions to get back on

- We have been asked what is causing the dip in emissions in the central scenario in 2035 in the below chart? It essentially brings central into line with engaged people and implies a more aggressive trajectory than the innovation scenario. 2035 is the critical date from the perspective of setting the sixth carbon budget. I wondered if central was effectively equivalent to engaged people in 2035 because we are trying to deploy enough heat pumps over the period to keep full electrification in play, and on the basis these are the technology which probably have the biggest impact on emissions?
- Looking at the opex costs in the below, we have been asked what is driving the kink around 2025 for central and innovation only? Looking back at the central spreadsheet, it looks like it is the hybrid H2 boilers, but I don't entirely follow what is driving increased opex for these homes, or why it is only these two scenarios we are seeing it in? I don't think it appeared in the previous run I used to develop the opex slide for the champions?

- The annual opex costs in yellow in your chart below look very high and do not seem to tally with the chart above (especially given you mentioned this represented the engaged people scenario)?

Other steers

- I had a call with the team working on skills at Eunomia for the CITB yesterday following the numbers you provided in my absence (thank you for this). It transpires that they actually expect to have a working skills model by the end of next week (earlier than I had anticipated) and as you know they will be running our central scenario through it. There is a risk that their model finds our central scenario undeliverable. This is obviously not something we can do anything about at the moment, but flagging as we will need to think about the implications if it happens.

- We talked briefly about timelines and reporting. I don't yet have an update on the drafting deadlines but I think in any event I will need a draft of the report by the time I return at the beginning of Sept so that I can get on with drafting in the two weeks when your team are likely to be taking some leave.

- Some of the 'killer charts' may be needed before I get back, as [Name redacted] will be using them to feed into some materials we will be using for some discussions with ministers and others. We got timed out today on discussing the charts so I suggest I send an email round the key people and copy you in so you can see any feedback directly, including any thoughts people wish to send on in my absence.

Finally, I've added a response in line below. I may follow up with a few more responses/any other questions that I get following the meeting this morning.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 13 August 2020 10:53

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: Timelines & QA Log

Hi [Name redacted],

Please see our in-line responses below.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 12 August 2020 13:37

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Timelines & QA Log

Hi [Name redacted],

Thanks very much for the answers below.

I decided to replan to start going through the scenarios this morning, to maximise the time for any qs (I've got a meeting scheduled for tomorrow at 11 to go through the high level scenario nos with [Name redacted] and [Name redacted]). I've set out below the things I've spotted/have queries on:

- I am not seeing 0 values for fossil fuel use in 2050 in the scenarios. Gas and petroleum seem to be showing a very minor negative fuel use, and there is a small amount of positive fuel use in solid fuel and bio for some reason?

- o We are looking into this. As a first QA check, we have confirmed that we have 100% LCH uptake by 2050.

- I want to be able to talk to the drop we have seen in hydrogen consumption in 2050 relative to net zero. Essentially in net zero we had 40 TWh of hydrogen and in 6CB central we have 14 TWh. I know this is a question I have asked before and I believe [Name redacted] said that district heat was part of the answer given that it no longer uses hydrogen in most of the scenarios. Looking back at the net zero numbers, this should account for ~11 TWh in 2050. However I can't work out/remember what else is driving the hydrogen reduction, as we have similar nos of hybrids and I believe our hydrogen boiler efficiency has gone down. Reduced heat demand from the warming climate will be a contributor, but wouldn't seem to explain the scale of the difference?

- o DH was using H2 peaking in Net Zero Central, which has roughly the same effect as another 5m H2 Hybrids.

- This could account for around half of the NZ H2 demand (~20 TWh) as the hydrogen peaking was very similar to a hybrid in terms of share of demand met by H2, and we had just over ~5m DH and around ~5m hybrids roughly. The bit I don't follow is why DH H2 was only 11TWh in net zero?

- o Additionally, we have 3.9M H2 hybrids (vs. ~5M from NZ); this is roughly a 22% reduction (or a difference of an additional ~4 TWh).

- o The remaining small difference (~2 TWh), as you say, could be related to a lower heat demand (e.g. baseline heating demand starting point, differences in energy efficiency uptake, and additional warming climate reduction).

- On the emissions in 2050, thanks for pasting that and sorry for missing it in the previous email. Looking at the final emissions we have across scenarios, we have max and engaged people reaching close to zero around 2044 and the others around 2048/49. I know I have asked before what the low tail of emissions is in max and engaged people after 2044 and I believe the answer was district heating which is based on the 5CB profile and therefore only fully rolls out by 2050, is that correct?

o This is correct. DH is the cause for this effect.

o This pattern (and the below two points) can be seen in the trajectory output analysis files sent over previously.

- Max/Engaged People uptake ~100% of their LCH by 2044, with the exception of DH still being deployed to 2050.

- Other scenarios uptake ~100% of their LCH by 2048, with the exception of DH still being deployed to 2050.

- For the DH component of the scenarios, I'd like to understand the modelling approach a bit further (and a hopefully helpful reminder that we'll have to write this up in the report too).

o I understand that bio is excluded from all DH fuel mixes

- This is correct (this update to the 5CB mix was made during the NZ study and retained for the 6CB study).

o I understand that for all scenarios except headwinds, gas and hydrogen is excluded such that we have an electricity dominant mix. This is correct Do our mixes still assume some contribution from waste heat etc? I am keen to understand to what extent the 5CB mixes have been translated into the mixes we are using now.

- Aside from the removal of Bio as noted above, the fuel mix for DH is the same as for 5CB, which includes the high T and low T waste heat sources. When the Bio was removed during the NZ work, the HP-based supply options were increased to fill the gap.

o I understand that when a home goes onto DH it goes directly onto a decarbonised mix. This is correct (with the caveat that in Headwinds, the peaking includes natural gas until natural gas is entirely replaced by hydrogen according to the Headwinds hydrogen grid conversion trajectory). In the report

worth being clear on this, as there are ~500k homes on DH at the moment (mostly gas CHP) and I think in reality the scenarios reflect the fact that in the early years these start to get moved onto decarbonised heat mixes.

- This is fair – as discussed, the use of the 5CB curves leads to a perhaps over-optimistic deployment in the early years, since 2020 was 5 years into the future at the time of the 5CB. We can consider ways in the narrative to recognise this imperfection but also justify it to some extent as with your suggestion.

- o Helpful to understand how the 5CB uptake profile has been translated into the 6CB uptake profile?

- We are using the same curve that we used for NZ, which has a start year of 2020 and end year of 2050.

- Thanks very much for the charts splitting out heat pump replacements from new installations – this is definitely valuable for the reporting. Would it be straightforward to include also for annual installation rates to help inform policy? There are a couple of things I am not quite following in the numbers:

- o The attached has annual installation rates for both new retrofits and retrofit replacements.

- o I tried to cross check the numbers in the attached (see BO3 on LCH uptake tab) with those in the ‘HP deployment constraints 040820’ file which I understand should be consistent. However the numbers post 2023 seem to be different, do you know why that is? Amongst other things, I can see that in the deployment constraints file the numbers are increasing post 2036 whilst in the attached file they seem to be decreasing. I wondered if the numbers in the trajectory output file I was comparing to, might exclude replacements but from how the charts are composed this doesn’t seem to be the case? I am no doubt missing something obvious.

- The Central trajectory was updated slightly before running so the numbers in the ‘040820’ file are out of date (the same was done for Widespread Innovation). We have attached an updated file which should match exactly (and includes new column with replacement numbers from 2036).

o Am I right in thinking that the numbers in the HP deployment constraints file should remain correct and consistent with the latest scenarios?

- Yes, but in the attached HP Deployment constraints file rather than the slightly outdated 040820 file.

o I've been taking more of a look at the drops seen in HP retrofit numbers and trying to understand them against your broken down charts.

- In max and engaged people we see a drop off from 2044-2045 (drop of 500k in max and ~650k in engaged people). This makes sense to me as it is occurring 15 years after the phase out of fossil fuels on gas. From your charts it is clear that it is the point at which we shift to replacements rather than new installations.

- That is correct. Uptake reaches 100% in 2044 so from 2045 onwards only replacements are being deployed.

- In central and innovation as [Name redacted] pointed out, the drop is seen in 2036 (drop of around 750k from year to year in central and 460k in innovation). You suggested that it is due to the replacement cycle starting given 2036 is 15 years after 2021. However, given new installations will still be ongoing (with the phase out date on gas being 2033), it doesn't make sense to me that you'd see a drop off from 2036, would you not expect to see higher deployment because you are now doing replacements too? Again I might be missing something obvious.

- This is due to the H2 hybrid deployment, which reaches 100% by 2035 in both scenarios. In Central, 20% of the 3.9M H2 hybrids (780k) are deployed between 2034 and 2035, with no further deployment from 2036. In innovation, 11% of the 3.4M H2 hybrids (375k) are deployed between 2034 and 2035, again with no further deployment from 2036. The remainder of the discrepancy in Widespread Innovation is due to the on-grid pure HP deployment curve, which slows down slightly in 2036 as the mandate date comes into effect (accounting for a decrease in deployment of 120k).

- [Added to the list, based on yesterday's discussion] Why does the fuel poor energy efficiency have a steep jump (shallow in the early years and then very steep)?

o This is due to the 2030 backstop requirement. The early year deployment is slow to keep the uptake reasonable in the first 5 years (and within deployment constraints), but accelerates rapidly in the late 2020s in order to reach 100% by 2030. This is true for all scenarios.

Separate to the above, good to also to understand timings on when you expect to be able to send through the headwinds scenario. Were you planning on also sending a scenario summary file? I am about to start looking at the high level scenario costs for which it would likely be helpful, but appreciate things are busy so not sure if possible to share at this stage.

I'll continue going through the scenarios you sent over now so may be back in touch in the event of further questions.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 11 August 2020 12:50

To: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Subject: RE: Timelines & QA Log

Hi [Name redacted],

Please find our in-line responses for all items below.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 11 August 2020 11:02

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Timelines & QA Log

Hi [Name redacted],

The fitted tank cost was accounted for indirectly, as we include this service/portion of cost in the opex (£65/y) since we model the renting of a tank rather than buying it outright (per the assumptions log: £65 added to opex to reflect delivery and storage of gas).

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: 11 August 2020 10:56

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Subject: RE: Timelines & QA Log

Hi [Name redacted],

Thanks very much for this. On the bio capex point, when you compared the delta EE nos to the other evidence sources for bioLPG boilers, did you include the bioLPG tank cost I had mentioned (I think £550) in the comparison (i.e. checking delta ee costs consistent with bio LPG boiler plus tank) or did you look at the boiler only?

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Sent: 11 August 2020 10:38

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Subject: RE: Timelines & QA Log

Hi [Name redacted],

On that point, the transition from biomass is largely due to the replacement of the counterfactual systems with LCH (similar to any other counterfactual --> LCH uptake), with prior minor reductions in fuel use due to the uptake energy efficiency. As such, this will be a combination of all the aspects accounted for in the trajectory development (e.g. mandate dates, heating system end of life, deployment constraints, etc.).

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 11 August 2020 10:36

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Timelines & QA Log

Thanks [Name redacted], are you also able to help with the second bio heading below it?

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 11 August 2020 10:31

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: Timelines & QA Log

Hi [Name redacted],

Please find our in-line response for the bio item below. We will follow up later with responses to all items.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk> [mailto:[Email address redacted]@theccc.org.uk]

Sent: 10 August 2020 19:30

To: [Name redacted] <[Email address redacted]@element-energy.co.uk> [mailto:[Email address redacted]@element-energy.co.uk]

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> [mailto:[Email address redacted]@element-energy.co.uk];
[Name redacted] <[Email address redacted]@element-energy.co.uk> [mailto:[Email address redacted]@element-energy.co.uk];
[Name redacted] <[Email address redacted]@theccc.org.uk> [mailto:[Email address redacted]@theccc.org.uk]

Subject: RE: Timelines & QA Log

Hi all,

I've added in a comment below from [Name redacted] too,

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 10 August 2020 16:20

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Subject: RE: Timelines & QA Log

Hi [Name redacted], all,

Hope you had a good week last week. I did, although I can't recommend moving house as a relaxing activity for a week off! Glad to have move space though now we've done it.

Many thanks for sending this and the other updates over the past week. I have now been through my emails and have responded/added some questions below. I have put the bio questions first as I have a meeting with BEIS at 11 tomorrow that it would be helpful to understand the answers for if possible:

Bio boiler costs

We agreed that the costs would be modelled as bioLPG but that in all of the write up we would refer to biofuel boilers or similar rather than specifying bioLPG as the solution. Nonetheless keen that in the assumptions log the costs we write up are coherent and I'm still just trying to make sure I understand the rationale for your chosen costs here. The majority of off GG fossil heating systems currently are oil boilers (table 1 here: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/831069/Bioenergy_heating_options_in_off-gas_grid_homes.pdf) so in most cases it will be a case of switching out an oil system. We have costs which are consistent with BEIS' oil boiler cost assumptions which are quoted in the assumptions log at £1570 plus 300 for the control unit, which you checked were consistent with the bioLPG system costs as per the last attached email. Looking at my numbers at the bottom of the attached email however, I flagged bioLPG system costs of £350-£2500 plus installation costs of around £700 (so £3675 mid range) plus £1350 for removal works of old oil boiler and tank. I'm just trying to understand how these reconcile with your costs?

- Considering that we only have Bio Boilers as a hybrid unit, we have used the consistent £1570 plus £300 as you note above.
- Regarding installation costs, we only take into account the HP installation cost as previously agreed; this is optimistic on the costing, but is what we had chosen to do for all hybrids (i.e. we are not accounting for additional installation costs separately for the boiler).
- Aligned to NZ assumptions, there is also no removal cost added, as we do not account for removal cost for any boiler-based hybrid technology configuration. Therefore, we do not account for it here.
 - o For non-boiler-based LCH technology uptake, we account for a £519 decommissioning of boiler.
- The fitted tank cost was accounted for indirectly, as we include this service/portion of cost in the opex (£65/y) since we model the renting of a tank rather than buying it outright (per the assumptions log: £65 added to opex to reflect delivery and storage of gas).

Bio uptake

Thanks very much for sending the trajectories here, extremely helpful. Can I ask how exactly the transition away from biomass is being driven in the scenarios? Is it effectively heating system end of life?

- The transition from biomass is largely due to the replacement of the counterfactual systems with LCH (similar to any other counterfactual --> LCH uptake), with prior minor reductions in fuel use due to the uptake energy efficiency. As such, this will be a combination of all the aspects accounted for in the trajectory development (e.g. mandate dates, heating system end of life, deployment constraints, etc.).

Timelines

The element I can't spot in the Gantt are the reruns. Good to discuss what the most sensible timing is here? I understand from central team that they can make do with the runs that they have for the Committee meeting on Friday, so I think the timing for the runs will be led more by what we need to keep us on track for reporting?

- We have performed the reruns, apart from Headwinds (as there persists an error that we are trying to solve). We have also completed the templates (apart from Headwinds) and can send them to you shortly.

Adaptation measures

Helpful to know where the shading costings have got to over the past week. I believe I left you with the inputs from [Name redacted] in the attached, but I couldn't spot any further emails since I sent this. Have you now had a chance to share some costs with [Name redacted]?

- Sent an email on this yesterday.

In relation to the ventilation, as per the first attachment I think we need to firstly cost up the ventilation in the kitchen and bathrooms that [Name redacted] provided costs for. I think then at a minimum we would want to cost MVHR for those homes getting the Energiesprong-type packages in the innovation scenario, and ideally (subject to whether we can get some further input from CIBSE over the next few days) we might include costings for a slightly broader range of home types/for MEV as well. I have attached the best cost estimates I have for MVHR at the moment which I think we can use as a basis. I have sent out a chaser email to try to check these so will let you know if I get any updates on this front too.

- Thanks for providing these costs. To avoid duplicate work, once the method of implementation and costs are finalised, we can incorporate this.

I think you should have the inputs you need to pull together a first cut of some of the high level adaptation costs here but please let me know if you are still missing anything.

- It would be good to get your steer/confirmation on the following:
 - o Which set of shading measures we should account for and which segments of the stock they should be applied to.
 - o MVHR costs and which segments of stock they should be applied to.
 - o Any variation by scenario.
 - The final output specification (i.e. a 2050 figure on total cost based on measures in the stock; separate analysis to be presented in the report, aside from the template population).

Emissions reaching zero

One of the other comments I left you with on the scenarios before I headed off was in relation to the fact that emissions in 2050 did not appear to be zero. Are you able to update on resolution here and approach for ensuring that the final runs reach 0 in 2050 across scenarios?

- The reason for these residual emissions was noted in the "RE: GWP issue"; email chain. Please see the explanation copied below:

o Please see the table below which shows the residual emissions noted by scenario:

Central Max			Headwinds			Engaged People			Widespread Innovation		
CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O	CO2	CH4	N2O
CH4	N2O	CO2	CH4	N2O							

2050 baseline direct emissions [tCO ₂ e]	58,546,190	1,175,361	156,760
58,546,190	1,175,361	156,760	58,546,190
58,546,190	1,175,361	156,760	58,546,190
58,546,190	1,175,361	156,760	58,546,190

2050 abated direct emissions [tCO ₂ e]	58,546,190	1,174,428	156,085
58,546,190	1,175,361	156,760	58,546,132
58,546,190	1,175,361	156,760	58,546,190
58,546,190	1,175,361	156,760	58,546,190

Residual direct emissions [tCO ₂ e]	-	933.08	675.48
-	-	-	57.64
-	-	-	-
-	-	-	-

o As you will note, only Central and Headwinds have this occurrence. This is due to two reasons:

- Residual non-CO₂ emissions in both Central and Headwinds: this is a result of the BioLPG use and its relevant direct CH₄/N₂O emissions.
- Residual CO₂ emissions in Headwinds: this is a result of very few 'None's that are being taken up in Headwinds (we are aiming to resolve this as soon as possible).

Emissions calibration

The magnitude is low so I think it is a nice to have, but with the updates to the new build numbers, the 2018 emissions to calibrate to will change very slightly. Is this something you can accommodate?

- As discussed with [Name redacted] previously, the template outputs will align with the currently agreed baseline numbers and the modelling inputs can no longer be updated. For any further adjustments, feel free to manually update (e.g. adding/subtracting to the baseline total, as well as to emissions abatement total) after we send over the final templates per your discretion.

Heat pump trajectories

Many thanks for the updates to these. I think they look reasonable and point noted about the constraints breach in engaged people. I am just double checking others are also comfortable so we can use for the final runs.

- As stated earlier, we have run the scenarios already. However, as you say, it would be good to get the confirmation as well.

We've had a query from [Name redacted] on the profile in central which looks a bit odd in the 2030s, with a big fall off in retrofits from 2035 to 2036 and then growing back to a similar level by the 2040s (there's a similar effect in Innovation too, but not in People) is the 2040s effect due to replacements as well as continued new installs? If so, [Name redacted] has asked if it is possible to break the retrofits into those two categories, and to understand why it happens in some scenarios but not all?

- As you say, this is likely due to the replacement cycle starting. To break this down, you can simply subtract the uptake 15 years prior. For example, the

[2036 uptake] – [2021 uptake] = [New 2036 uptake], where the [2021 uptake] will represent the portion of the [2036 uptake] which is due to replacements.

Naming in template

Will the next runs you produce have the updated naming conventions? Please let me know if necessary to discuss further to finalise.

- If you are referring to the Bio Boiler naming and the updated measure definitions tab, these should be accounted for.

Other stats on energy efficiency

We have talked about this briefly before and what statistics we might be able to pull out on energy efficiency that can help people understand the levels in our scenarios and how they evolve over time. Keen to see in the next iteration of your report skeleton what you think might be possible here (given that the % savings from heat demand only tell part of the story). Would it be possible to include something along the lines [Name redacted] was asking for previously, so relating to homes treated? We have the challenge that homes get EE incrementally in many cases, but a trajectory for the % of homes that have received all their designated measures by each date could be helpful (e.g. it would hopefully illustrate that most homes should have reached their designated EE level by 2033 in central), or perhaps % of homes receiving a measure in any one year?

- Sent an email on the first point yesterday.
- Please see below for are our Central EE trajectories, from the templates (N.B. we model by measure uptake rather than individual home uptake).
-
- We have rapid uptake up to 2028, which is the backstop date for PRS and SH. Then, 2030 is the backstop date for OO FP. After this, the deployment slows as the non-FP OO segment is completed.
- On the incremental aspect, the effect on the actual curves is fairly small (the final amendments to these curves resulted in the difference between the uptake of the slowest measure and the fastest measure to be small between 2020 and 2030, in order to satisfy other constraints. Of course, as agreed, we can elaborate on this more the narrative.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 07 August 2020 11:51

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Timelines & QA Log

Hi [Name redacted],

Please see the updated Gantt and QA log.

You will note that the timeline is now quite aggressive, particularly for the upcoming week, considering the recent changes / additional tasks that have come up in the past two weeks and upcoming leave on your/my end. We will need to manage it closely and make sure we are able to (at least to realistically aim) for a completed version of the report prior to your annual leave. It would be good to get your thoughts on this.

Considering that there are two weeks left until then, per your suggestion, I have put in three suggested dates for us to send you a draft version of the draft report to obtain your feedback; however, this is likely to be more fluid as we continue to progress.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: 23 July 2020 19:20

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Timelines & QA Log

Thanks [Name redacted], I will take a look. On the latter point, it relates to the descriptors for each line item. I believe at the moment we have condensed descriptors in the templates, but I think we need to agree an expanded set.

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 23 July 2020 19:16

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: Timelines & QA Log

Hi [Name redacted],

Please find the attached file, in which you will see the revised project timeline/gantt, the draft QA log, and a summary of the scenario guidance QA in specific. Let us know your thoughts on these items when possible.

One other item, regarding an entry on the to do list, that we need clarification on was the following: Final line item descriptors to be agreed across columns for populating. Could you please provide more detail/guidance on this point for what needs to be done?

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

w: www.element-energy.co.uk <[https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C\[Name redacted\]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0](https://eur01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.element-energy.co.uk%2F&data=02%7C01%7C[Name redacted]%40virtuoso-uk.com%7C60c768cf5a884f5df37208d7217e56b5%7C93f669155b6048a1a5739d4cf9e084a4%7C1%7C0%7C637014698865930518&sdata=j%2B2xJGS%2By%2BiLHqkhJuDyQyPb7%2Bfvu6GXgkxDthefgCY%3D&reserved=0)>

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From: [Name redacted]

Sent: 14 August 2020 18:36

To: [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]

Subject: District heat trajectory

Follow Up Flag: Follow up

Flag Status: Flagged

Categories: Red Category

Hi [Name redacted],

Please find attached a trajectory we have worked up. Please do let us know if you spot anything untoward. Grateful if we could call the line item 'low carbon district heat' in the modelling.

[Annex F]

Many thanks and hope you have nice weekends,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate Change<<https://www.theccc.org.uk/>>

[Telephone number redacted] | @theCCCuk<<https://twitter.com/theCCCuk>>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 16 September 2020 11:49

To: [Name redacted]; [Name redacted]; [Name redacted]

Cc: [Name redacted]; [Name redacted]

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Follow Up Flag: Follow up

Flag Status: Flagged

Hi [Name redacted],

Many thanks for sending this through so quickly and sorry you were working so late on it – the prompt assessment has been extremely useful as it has taken some time for me to work through this morning.

I wanted to get queries back to you asap today so have set out below – if there is an opportunity to narrow down the query list in advance of the meeting via email I think that would be really helpful, as it would enable us to focus the chat at 4.30 on the biggest outstanding queries/uncertainties (I also note that I am sometimes better when being able to ponder things on my own than giving live reactions, so responses in advance helpful to the extent possible).

Fingers crossed I can get to the point of understanding the approach by the end of today and we can come to a mutual view on how to proceed, so that the runs can be commenced. In the worst case, where we don't manage this, it may require a chat with [Name redacted] first thing tomorrow (as I'm not sure whether she can make the meeting at the end of today). Good to understand to what extent this would jeopardise delivery of the updated scenarios this week.

I have set out below a) our views on the decision points b) things we are not quite following and c) broader methodological points. The points under b) in particular may be indicative of misunderstandings on our part, of errors, or of intentional simplifications (which lead to known inaccuracies considered necessary but manageable in the context of the constraints we are working in). Good to try to understand which queries fall into which camp.

A) Decisions

- Suggest that CoC for the centralised components is kept at 7.5% across scenarios. Best for the in home components to be subject to the varying CoC though as I presume they already are?

- Agree with your inclination to try to keep things consistent/simple by having the network pay off in 20 years, but retaining lifetime of 40-60 years.

B) Things we are not following

- Rows 20 and 21 in 'CALCULATION' tab looks to remove EfW and bio and retain gas peaking. I need to try to look back over net zero emails to remind myself of the logic on EfW (presume we made this decision then). For most scenarios shouldn't gas peaking also be removed (such that it is fully decarbonised from the outset)?

- In terms of trying to follow the relationship of heating sources to non-network capex in step 3, we are seeing a profile which is highest in the earliest years, and lower in late years, with a dip in the middle. Based on slide 9 of the DH report, gas dominates in 2015 (which I can't see has been edited on your heating source adjustment tab). Why would non-network costs therefore be the highest in this period? Is the dip from 2025 to 2035 expected to be indicative of waste heat accounting for a higher proportion over this period relative to more expensive sources?

- As a result of 20 year lifetime for annualising network capital costs (but 40-60 year lifetime in use) I would expect network capex per unit of heat to be fairly constant to 2035 and to only start dropping thereafter as the costs get paid off. However we are seeing a profile where they increase to 2024 and drop off following this, do you know why is this?

- Related to this, our new trajectory has v low deployment in early years and higher deployment in late years which would be expected to lead to a different network capex profile than is implied in row 64 in 'CALCULATION' tab, implying that the costs in the early years are overestimated and later years underestimated. In real life we think the networks should actually be built in the early years (i.e. with gas CHP), so perhaps less of an issue, but the network costs presumably won't fully reflect this early build either, as they will be multiplied by lower TWh of deployment. We knew there would be inaccuracies in the investment profile so my key question here is really intended to try to understand the nature of these inaccuracies. Keen to get your view on whether investment costs in aggregate over the period will be broadly accurate which I think is the main objective?

- Step 2 in 'CALCULATION' tab seems to draw on 5CB lifetimes, for completeness this should be 6CB lifetimes?

- PMT is type 0, i.e. discounting at end of yr 1. As per worked example should be type 1.

C) Broader methodological queries/points

- I am not quite clear on how the nos in step 3 are subsequently used in new measure and average measure £/t calcs, are you able to explain?

- One thing I have been struggling to get my head round is to what extent the costs used in the remodelled outputs will remain influenced by the old 5Cb trajectory rather than being fully reflective of the new trajectory? I think this

links to the questions above. For instance, as I understand it, rows 63 and 64 will inherently reflect early year deployment, such that even if we multiply the resulting nos back by the profiled down TWh in year, the costs in e.g. 2020 will to some degree still be reflective of schemes being built earlier as per 5CB trajectory? It may be that there is an intended simplification/inaccuracy here but if so trying to get my head round what it is?

- Helpful to understand whether you propose to adjust the investment costs in model as part of the updates, or if I still need to plan a post processing step of some kind in respect of this?

I will continue to think about this in the interim so some of it may become clearer to me as I do so.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 16 September 2020 00:04

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted], [Name redacted], [Name redacted]

Please find attached as described below a draft methodology to update the DH Network and Non-network capex costs using the 5CB outputs.

I have annotated this with some notes, and the original output data from 5CB and Net Zero is included in the separate tabs, to aid understanding.

However, I expect it would be helpful for us to discuss – as mentioned below, I think the earliest opportunity will be the catch up at 4.30, so if you were able to take a look before then we can discuss any questions on the call.

Thanks,

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Sent: 15 September 2020 20:21

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Agree this is great news. I was thinking the main reason for identifying CoC is to correctly calculate investment costs – less worried about the scenarios as [Name redacted].

[Name redacted]

From: [Name redacted]

Sent: 15 September 2020 18:16

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted],

Many thanks for taking the time to get to the bottom of this, it is very much appreciated. Yes agree on the importance of getting a decision on this tomorrow, so that sounds like a very good plan. On cost of capital it would be valuable for me to briefly discuss with [Name redacted] whether we want to go to the effort of varying it between scenarios as arguably 7.5% is a more realistic expectation for DH centralised capex, given the costs are in the first instance incurred by a commercial entity? It sounds from your description like the below will allow us to better separate out investment costs too which would be fantastic.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 15 September 2020 18:03

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

[Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

We've spent some time going back through the 5CB outputs and the DH calculation today and we are nearly there in bottoming it out including working through a corrected (and also improved) approach and comparing the costs with the current figures.

I plan to send over a worksheet with all the calculation steps, starting from the outputs of the 5CB work, so that we can have those signed off and agreed with you to resolve this question properly. I hope to send that later tonight or otherwise tomorrow morning. Once you have had a chance to review the calculation, it would be good to discuss this during our catch-up call tomorrow so that we can make a decision (in theory we could have a separate call earlier but diaries look quite difficult for that).

As part of the analysis today I can clarify on the cost of capital and discounting question below. When I reviewed the 5CB outputs recently I understood that the costs had not had a cost of capital applied and were not discounted, as they appear in the outputs as a single figure in one year. However, on closer inspection of the 5CB model today, I have established that these are not simple investment costs but 'net present costs' which (as per p60 of the 5CB report) include both a cost of capital of 7.5% and discounting of 3.5% in the Central scenario. The 'improved' approach that we are proposing now includes a back-calculation of the in-year investment cost, removing the impact of the cost of capital and discounting, and then reapplying the cost of capital varying by scenario as appropriate to the 6CB work. The discounting will then applied to the annualised capital costs in the main model. The file I will share will show the 5CB outputs and the subsequent calculation steps so you can trace these back to the 5CB as far as we can go.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Sent: 15 September 2020 17:25

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted],

Thanks for this. Good if when responding you might also be able to confirm treatment of cost of capital/discounting in the levelised cost of heat numbers. On the phone you suggested cost of capital was not included, also confirmed in my email of the 10th September (also repasted below):

- The abatement costs will be an underestimate as the costs of capital won't have been applied to the levelised costs of heat, which are treated as opex, even though a component is capex Yes

Speaking to [Name redacted] about it though and looking back at the report, it seems to confirm that cost of capital is included in the levelised costs of heat at 7.5%, and that discounting is included in some way? It would be very much appreciated if you could clarify.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 15 September 2020 09:54

To: [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted], all

As a quick update, I looked into the DH cost calculation (done originally as part of Net Zero) and have identified the source of the issue. The calculation derives the lifetime levelised cost of heat delivered from the schemes built in each year (which is correct) but then defines the applicable cost of DH heat in each year based only on the schemes built in that year, rather than the weighted average of all schemes contributing to the heat supplied in that year (which is not correct).

I am in the process of updating the approach to correct this and align better with the approach for other technologies, and will share this once we have the equivalent cost of DH heat in p/kWh to compare with the current values to understand the size of the current discrepancy.

I/we will need to do this alongside other meetings today, but we'll send it over as soon as we can.

I'll take a look at the question you raise below once I've been able to work through the DH update.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk

Sent: 15 September 2020 07:24

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Thanks [Name redacted]. Let us know where you get to today with the DH and we can take a call on how to deal with it. Keen that in any event we have the final runs complete at the end of this week so that next week can be fully report focused/allow time to feed into [Name redacted]'s ministerial presentation.

In the meantime I set up a spreadsheet for the opex cost reallocation to investment costs in the template. However I have realised a complication. The process I have taken is as follows:

- Multiply the deployment nos by £104, which is the opex I understand to be associated with the heat interface unit and meter. Retain this in the opex column.

- Of the remaining value, split it into opex and capex based on the proportions implied by interpolating the numbers in rows 7 to 10 in the DH 5.2 file, and reapportion to the opex and investment rows respectively.

The complication that occurred to me is that the numbers in the opex column in the template should be net rather than total opex. I think this means that:

- I shouldn't go through the step of removing the building level opex, because all of the counterfactual technologies have equivalent opex (resistive, storage, gas and oil all have £104 too).
- Apportioning the full net opex cost according to the proportions in the DH file is not quite right, because the proportions will presumably alter in a non-uniform way after the counterfactual opex has been removed?

Is that right? I'm not sure how the reallocation you did for net zero dealt with this and whether I could replicate/whether there is some other data I should be using?

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 14 September 2020 13:25

To: [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] &[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] &[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

Yes, that is correct on both counts.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>

Sent: 14 September 2020 12:52

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi all

So that I understand:

1. We have a likely error in the way the DH costs have been interpreted which suggests they are in-year rather than average abatement costs. This could well be driving an underestimate in total costs (assuming costs fall over time) or an overestimate (if they rise over time).

2. Separately, there is an error on the hybrid H2 heat pumps, which means we are currently overestimating abatement in Headwinds and Innovation (particularly the former).

Correct?

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Sent: 14 September 2020 12:10

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

Yes, that's my view on the DH issue too.

The H2 discrepancy for Innovation is similar to the Central scenario. For Headwinds, it is of a similar scale, but importantly it persists beyond 2035 since the grid conversion persists to 2050. The table below provides the equivalent discrepancy in terms of the number of Hybrids (the error means they are currently assumed to be on H2 but are actually on Gas). This is 0-1 million until 2038 (hence a similar scale to Central over the 6CB period) but increases to more than 2 million in the 2040s.

Number of H2-converted Hybrids					2023	2024	2025	2026	2027	2028	2029
2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
2042	2043	2044	2045	2046	2047	2048	2049	2050			
Headwinds - existing (error)								-		-	
-	-	-	-	-	-	-	-	-		-	
-	-	-	-	-	-	-	-	-		119,850	
594,427		1,192,817				1,718,394		2,608,494		3,859,838	
5,318,847		6,560,744				7,328,886		8,029,792		8,303,075	
8,560,772		8,888,558				9,145,677		9,474,821		9,500,035	
Headwinds - corrected							-			-	
-	-	-	-	-	-	-	-	-		-	
-	-	-	-	-	-	-	-	-		33,558	
194,972		448,499				728,599		1,231,209		2,007,116	
3,021,105		4,041,418				4,866,380		5,717,212		6,310,337	
6,917,104		7,608,606				8,267,692		9,020,030		9,500,035	
Difference						-		-		-	
-	-	-	-	-	-	-	-	-		-	
-	-	-	-	-	-	-	-	-		86,292	
399,455		744,318				989,795		1,377,285		1,852,722	
2,297,742		2,519,326				2,462,506		2,312,580		1,992,738	
1,643,668		1,279,952				877,985		454,791		-	

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>[Email address redacted]@theccc.org.uk>

Sent: 14 September 2020 11:37

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Thanks [Name redacted]. Re the DH it is very hard to judge what to do about it in the absence of knowing more about the nature and the scale of the issue, and on that basis I think it is too early to rule out the need to discuss reruns – am I right in thinking this is your view too?

On that basis I have proposed to central team that we stick with the previous runs for headwinds and innovation ahead of the Committee meeting (I understand that the magnitude of the H2 error in central was small and presumed the same to be true for headwinds and innovation, but if quick for you to confirm that would likely be of help). I have asked them to let me know if they have any concerns with this approach so will let you know when I hear back.

[Name redacted] – please note that this means changes to the DH costs in the non-res modelling may be needed, and thank you for posing the question about the declining cost trajectory in the first place!

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 14 September 2020 11:07

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

Thanks for the response. It's also my understanding that I'll need to look back into the Net Zero modelling to shed more light on the possible DH cost error. However, based on trying to rationalise the 2050 cost I think it's likely the costs are showing in-year costs, contrary to what I thought, otherwise I can't explain the fall-off in the later years.

I'll aim to look at this asap, but that is likely to be tonight or tomorrow as I have a full diary today; unfortunately it needs to be me looking back into this.

What we are most keen to avoid is re-running the other scenarios today, and then having to re-run them later this week if the decision is taken that we need to correct the DH costs in-model. Given that I think it is a distinct possibility that the DH costs are currently in-year costs, we would need to take a view now whether that is likely to be the outcome, in which case I would rather postpone today's re-runs until after this has been resolved.

Please let me know what you think. I'm available for a call until 12, but then tied up for the afternoon.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: 14 September 2020 10:33

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk>>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted],

I did thanks and hope you did too. Apologies, I didn't realise you were waiting for a response from me here. I am not totally clear on whether there is an error in the DH costs and if so what the magnitude of it is (e.g. if the LCOH represent in year rather than annualised costs, this would imply they have been used incorrectly in the £/t I think?) - I had understood [Name redacted] was going to look into this further.

If there is an error found we essentially will have to make a decision about what to do about it, which could be leaving as is and noting (lowest effort), making an off model adjustment to account for it, or rerunning (most effort). In the absence of more information I don't think we are in a position to take a call on this? I have so far made central team aware of the potential error and was planning on still providing them with all outstanding templates today on that basis, although it sounds like you may not have the same understanding?

Happy to have a quick chat if needed ([Phone number redacted]),

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 14 September 2020 10:19

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted],

Hope you had a good weekend with hopefully a little less stressful time in IKEA.

Just wanted to follow-up on the below to see if you had any further comments on [Name redacted]'s response below. We will proceed with the final re-runs of Widespread Innovation and Headwinds today once we have your go-ahead.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 11 September 2020 14:14

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

Please see my comments on this below.

Thanks,

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk

Sent: 11 September 2020 07:29

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted],

Apologies, I have added one further point on this below.

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 10 September 2020 21:27

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>

Understand we have not done this with the investment figures, but we established that I could likely perform a similar adjustment using rows 7-10 in the DH 5.2 file. My understanding is that to do so I would:

- Approximate the proportion of the opex costs not associated with HIU and heat meter, i.e. the opex representing the levelised cost of heat only Yes
- Use rows 7-10 to establish what % of this is associated with capex Yes
- Strip this out and reallocate to the investment rows. Yes

Might you be able to briefly explain what is driving the reduction in network capex from 2030 to 2050 in the costs as modelled? We’ll want to explain this and I haven’t been able to track down an obvious explanation in the report. I don’t think it can be to do with lifetimes, as per below we’d expect the annualised cost elements to be enduring as replacements come in. I wondered if it could be to do with the heat density of the networks dominating the mix, e.g. if networks are all built by a certain point and then costs come down as new homes are built and connect, sharing network costs across a wider customer base? The report on p76 of the report says that ‘heat demand within all zones decreases between 2020 and 2040 in the central case due to energy efficiency improvements (and despite population growth)’; so wouldn’t seem to support this hypothesis, at least between 2020 and 2040. Apologies if I’ve managed to miss something elsewhere in the report here.

This is a fair question and I cannot provide a fully satisfactory explanation at this point and may need to look back in more detail. A partial explanation is that network replacements were not included. The 5CB report explains on p65 that the network costs are levelised over a 20 year lifetime (I expect this was to reflect the way DH schemes have typically been financed with a 20-25 year lifetime, albeit up to 40 years is now more common) but given that the technical lifetime is more like 40-60 years we did not include replacement costs for the network. However, this still does not explain why the 2050 cost is so low as this should include the cost of networks installed from 2031 onwards. The low cost in 2050 instead seems to imply that the costs actually reflect in-year investment costs rather than annualised lifetime costs, which I did not think was the case. I don’t think I can resolve this without going back into the original Net Zero model which I was hoping to avoid, but may not be able to given this.

<https://www.theccc.org.uk/wp-content/uploads/2015/11/Element-Energy-for-CCC-Research-on-district-heating-and-local-approaches-to-heat-decarbonisation.pdf><[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2Fwp-content%2Fuploads%2F2015%2F11%2FElement-Energy-for-CCC-Research-on-district-heating-and-local-approaches-to-heat-decarbonisation.pdf&data=02%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256702472&sdata=JuqItK6i%2FpNX%2BZpbbwnfuSdkdqyHv3vfbvu%2FxFxJca3O4%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2Fwp-content%2Fuploads%2F2015%2F11%2FElement-Energy-for-CCC-Research-on-district-heating-and-local-approaches-to-heat-decarbonisation.pdf&data=02%7C01%7C[Email address redacted]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256702472&sdata=JuqItK6i%2FpNX%2BZpbbwnfuSdkdqyHv3vfbvu%2FxFxJca3O4%3D&reserved=0)>

We also talked through what other inaccuracies we need to note in the write up as a result of our simplified modelling approach and established:

- The profile of the investment costs will effectively be smoothed and won't represent the dates of investment I thought this was the case but the above point brings it into question
- The abatement costs will be an underestimate as the costs of capital won't have been applied to the levelised costs of heat, which are treated as opex, even though a component is capex Yes

Hope that all sounds ok and let me know if there is anything I've missed.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 10 September 2020 14:15

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

The agreed approach taken for DH, as I had understood was clear both for the 6CB work and Net Zero, is for all the DH capex (including energy centre and network capex) to be incorporated into the 'cost of heat' from DH seen by consumers. That is set out in the DH v5.2 file (and earlier versions). As such, DH is different from all the other technologies which are treated in more detail in the model in that those capex elements for DH are not allocated to the investment costs in the template, but are allocated in the same place as the fuel costs. The only items associated with DH that are included as investment costs are the building level conversion costs (emitter replacement where required) as these are treated in the model in the same way as for other technologies.

The 'cost of heat' from DH, as derived in the Net Zero study and used directly in the 6CB work, includes the energy centre and network capex in the way you describe i.e. accounting for replacements based on the component lifetimes and levelising the cost per kWh of heat delivered.

We can certainly describe this difference from the other technologies in the treatment of DH investment costs in the report. However, in anticipation of the follow-up, as noted on several prior occasions, we cannot revisit the DH analysis undertaken during the Net Zero project to extract the underlying investment costs and change the approach taken in the template as this is a substantial undertaking. I see this as outside the existing project scope since we were clear that we would use the DH approach and outputs from the Net Zero project without modification (other than electricity, gas and hydrogen fuel prices and CO2 factors which have been made consistent with 6CB) given the fee and time constraints. In addition, we are working very intensively to meet the reporting deadlines, and are already well beyond the project budget at this point.

I hope you can understand this perspective and that it will be sufficient to describe this difference within the report.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Sent: 10 September 2020 10:27

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Thanks [Name redacted], helpful to understand what you have defined as investment costs in the resi template- presume all capex and excluding opex and fuel costs? Do the investment costs as recorded exclude cost of capital and discounting?

Grateful if we could make sure to note the point you make on investment profile in the write up – do the abatement costs and investment costs then each account for the capex on an annualised basis using the respective lifetimes of the components, but effectively assume they are constant costs (as the end of each lifetime is followed by a renewal)?

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 09 September 2020 15:07

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Subject: RE: 6th Carbon Budget - methodology for district heat investment costs

Hi [Name redacted]

In the approach we have taken to costing DH, which uses outputs from the 5CB work in a simple way, we do not distinguish between supply to Resi and Non-resi customers from DH. As such, the same levelised cost of heat should be used for Non-resi as for our Resi modelling.

These are included in the attached file, which we have shared previously.

The total cost of heat from DH is given on row 37, with a tab for each scenario. This includes all cost components except the heat interface unit and heat meter in the buildings, which is added separately in the model. These costs for the Non-resi sector can be found on slide 147 of the DH report for 5CB here (costs in £2014):

<https://www.theccc.org.uk/wp-content/uploads/2015/11/Element-Energy-for-CCC-Research-on-district-heating-and-local-approaches-to-heat-decarbonisation.pdf><[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2Fwp-content%2Fuploads%2F2015%2F11%2FElement-Energy-for-CCC-Research-on-district-heating-and-local-approaches-to-heat-decarbonisation.pdf&data=02%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256702472&sdata=JuqltK6i%2FpNX%2BZpbbwnfuSdkdqyhV3vfbvu%2FxFxJca3O4%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2Fwp-content%2Fuploads%2F2015%2F11%2FElement-Energy-for-CCC-Research-on-district-heating-and-local-approaches-to-heat-decarbonisation.pdf&data=02%7C01%7C[Email address redacted]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256702472&sdata=JuqltK6i%2FpNX%2BZpbbwnfuSdkdqyhV3vfbvu%2FxFxJca3O4%3D&reserved=0)>

The breakdown of the levelised cost of heat between non-network capex (i.e. energy centre), network capex (pipes), opex and fuel costs is given in rows 7:10. I am not sure what scope you wish to include in investment costs; but that could be used to exclude opex and fuel costs if desired. I would caveat that these are levelised costs reflecting a heat price to consumers over the lifetime of the DH network to pay off the investment by the DH operator in year 0 of the scheme, and as such the data in the attached does not give a profile of actual investment costs over time due to this lag. It will not be possible to go back into the original dataset to construct this type of investment profile, as this would be a substantial undertaking that is not within the scope of this project.

I hope that is helpful.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Sent: 09 September 2020 13:44

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Subject: 6th Carbon Budget - methodology for district heat investment costs

Hi

Another question for you both!

I'm currently looking at how to estimate investment costs relative to baseline for non-residential district heat. [Name redacted] suggested that you have a methodology you could share, for doing this using your levelised costs for district heat.

Regards

[Name redacted]

[Name redacted]

Analyst - Buildings

Committee on Climate

Change<[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2F&data=02%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256712469&sdata=6X3m6cuu9h%2F893%2BEKbJ031%2FBoClikuGea4dinaxtDd8%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2F&data=02%7C01%7C[Email address redacted]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256712469&sdata=6X3m6cuu9h%2F893%2BEKbJ031%2FBoClikuGea4dinaxtDd8%3D&reserved=0)>

[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk> | [Phone number redacted] | @theCCCuk<[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=02%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256712469&sdata=gAmyKpoKg16M5SVUw1b%2B7sVTHc87Rcuxvgv9uGimqhk%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=02%7C01%7C[Email address redacted]%40theccc.org.uk%7C6907f9a3ebac4a2ed65f08d859cba1f0%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637358079256712469&sdata=gAmyKpoKg16M5SVUw1b%2B7sVTHc87Rcuxvgv9uGimqhk%3D&reserved=0)>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 05 October 2020 11:18

To: [Name redacted]

Cc: [Name redacted]; [Name redacted]; Thompson, Mike; [Name redacted]; [Name redacted]; [Name redacted]; [Name redacted]

Subject: RE: H2 hybrids in central

Follow Up Flag: Follow up

Flag Status: Flagged

Hi [Name redacted],

Thanks for this and for confirmation that you think the trajectory I provided is the one we should proceed with for central:

Yes, the general theory I think we were trying to follow for central was that hydrogen heat pumps get deployed at the point that homes on the grid get converted to hydrogen.

The rationale is that the 2033 phase out reg says something along the lines of 'you are no longer allowed to buy a gas boiler, unless you are in an area that is planned to convert to hydrogen';.

If you are in an area planned to convert to hydrogen, you will continue to replace your gas boiler with hydrogen ready gas boiler. Then at the point the grid is converted, you might get a hybrid H2 heat pump to help manage the bill impacts of hydrogen, or because you are incentivised to do so to limit the volume of hydrogen that needs to be produced.

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 05 October 2020 11:08

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Yes, row 89 is when homes actually gain access to hydrogen; after review, and your explanation before, think we are aligned and should be using the trajectory you provided. We will proceed with the updates and process as soon as we can.

Our previous inquiry was just to make sure that we did not want to emulate the H2 hybrid conversion from Headwinds (which is the South trajectory). However, agree that it makes more sense to use the overall H2 grid conversion trajectory as a basis to deploy.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 05 October 2020 10:10

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: H2 hybrids in central

Hi [Name redacted],

I was under the impression the line I was drawing on (row 89) represented when homes actually gain access to hydrogen, is that correct? If not what data would best represent this?

I have just tried profiling using the combined trajectory, then north, then south (with brown representing the hybrids), and am not quite following what is driving the shape in the south, although it may be I am misunderstanding what the row represents?

Combined

North

South

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 05 October 2020 09:57

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Unfortunately I will be on calls until 1pm so it would be helpful if you could clarify over email.

I may have some time to give you a quick call around 10:45, but at this point I cannot be sure if I will be available.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: 05 October 2020 09:54

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Subject: RE: H2 hybrids in central

Hi [Name redacted],

It may be easier to discuss briefly this morning when you have a moment, so I can better follow the profile differences. I'm free any time from now.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 02 October 2020 18:58

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Upon initial view, it looks like the provided trajectory is somewhat of a blend of the H2 boiler / H2 hybrid trajectories in Headwinds (i.e. combines North and South together), leading to an H2 grid conversion trajectory not exactly in-line with that used in Headwinds. Could you please confirm that this is what you intended?

On the timing and fee, we will get back to you Monday if any concerns arise.

Have a great weekend.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 02 October 2020 17:49

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk>
<mailto:Mike.Thompson@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Thanks very much for the brief chat and the confirmation on error correction being included.

You mentioned you hoped that it would be feasible to aim for end of Tues/middle the middle of next week and on that basis great if we could proceed as below (so a 1.5 day extension for a fee of £[fee redacted] excl. VAT). Do let me know if any concerns with this when you get a chance to speak to [Name redacted] and [Name redacted].

I've attached the modelling approach I worked up for the trajectory (row 192 on H2 and HP trajectory tab - pretty simple), do take a look and let me know your view on it. Worth QAing if you wish to use directly.

Have a lovely weekend in the meantime.

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 02 October 2020 15:40

To: '[Name redacted]' <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>

Cc: '[Name redacted]' <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk> & [Email address redacted]@element-energy.co.uk>;
Thompson, Mike
<Mike.Thompson@theccc.org.uk> & Mike.Thompson@theccc.org.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk> & [Email address redacted]@theccc.org.uk>

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Thanks for those responses and appreciate the change will mean that we no longer have a clean LCH conversion by 2048 in central. I am not quite following your answer in B)i so good to briefly speak about this when you have a moment.

I understand that you have included a limited no of QA stages so as per the below I will try to do some targeted QA at the point you have updated the templates before we proceed. Just to clarify, in the event things are spotted, am I right in understanding you would be able to address these as part of the work?

Also helpful to understand when you'd expect to be able to deliver the outputs next week in terms of resource availability (i.e. do you have capacity to focus Monday and Tuesday on this?)

Many thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 02 October 2020 15:16

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Please see our in-line responses below.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Sent: 02 October 2020 13:12

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: H2 hybrids in central

Many thanks for this [Name redacted].

A couple of questions on the deployment constraints issue:

- Am I right in thinking the below align with the ballpark scale of breaches you had been referring to? Yes, breaches are within the range we have previously assumed to be acceptable.

- The deployment constraint doc has ~2m as the limit from 2035, however I just checked back to the assumptions log to see what the absolute limit was and it looks as if 1.6m is recorded as the absolute limit – are these perhaps out of date? Yes that was an outdated number; we have corrected it and the assumptions log now has total HP deployment constraints (when we first populated that, it was only retrofit constraints; this has been updated).

I've also added a few responses below.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]@element-energy.co.uk]

Sent: 02 October 2020 12:07

To: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] & [Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>; Thompson, Mike & Mike.Thompson@theccc.org.uk<mailto:Mike.Thompson@theccc.org.uk>; [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>; [Name redacted] & [Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;

Subject: RE: H2 hybrids in central

Hi [Name redacted],

Further to [Name redacted]'s email below regarding the targeted project extension, we have put some thought into the required involvement and see the process as follows (including time estimates):

1. [Name redacted] to provide an updated grid conversion trajectory for the Central scenario (likely to be the Headwinds national trajectory; needs to be confirmed).

2. [2 hrs] Agree process to approve and/or revise the trajectory.

* Deployment constraints:

i. In the suggested remodelled scenario, we breach the HP deployment constraints (of 2M) between 2046 & 2049.

ii. Would be worth it if [Name redacted] could revisit this to create a slightly more ambitious scenario upfront so that we are under the 2M limit in all years. Pending answer above, I am not convinced it is worth remodelling in order to stay within the deployment constraints as we have

them. My thinking is that we only really sought input on deployment constraints to 2035 and I think it is pretty plausible capacity could continue to grow, particularly towards the end of the trajectory. I'm not sure the levels of certainty around the constraints in the late 2040s are sufficient to make it worth frontloading such that the level of the budget is suppressed. Agreed (the above had meant to be phrased as a question). Happy to keep as is with your confirmation regarding the deployment constraints.

* Conflicting trajectory guidance:

i. We need agreement (and we will need to account for this in the narrative somehow) that only this one technology, in this one scenario (i.e. hybrid heat pumps in Central) would not follow the mandation date approach (i.e. the 1/15 uptake after mandation year). This would be clearly visible in the reporting outputs such as the deployment/investment graphs. On the point about the narrative explaining that one tech doesn't follow the mandation date approach, I think that is true already in as far as we are already frontloading deployment around industrial clusters in such a way that it would be expected to create scrappage costs? Unless I am misunderstanding something here? That is correct. However, the implications here are that previously the H2 hybrids in Central/Innovation were being deployed early (and were only not following the mandation approach for only two years), and so would not show up as extra deployment after other HPs have finished deploying. As a comparison, the mandation date approach applies for H2 hybrids in Headwinds. This is something we will just need to be cognisant of in the reporting.

If you are talking about the deployment charts which show technologies by tenure, I think we would simply exclude this tech from them and say that this component follows a different trajectory? In terms of the investment graphs, I think it would have the impact of smoothing investment further so decrease the hump in the first half of the 2030s; if so I think that sounds right. We currently have % uptake charts of technology by on/off grid (rather than tenure) and total deployment across all technologies where late H2 hybrid deployment (i.e. 2049 and 2050) would be present and visible. As such, in this case, the scenario would be fully decarbonised (apart from DH) in 2050 rather than 2048 (as is currently) if we spread the deployment to 2050. And yes, the investment would be smoothed in the 2030s, but again may be noticeable after 2048 if we are still deploying H2 hybrids.

* Scrappage costs included in the model:

i. As discussed, this would not require to be updated (and this is our preference as well). However, if this opinion changes, it would add an additional 0.5 hrs.

3. [3 hrs] Update the H2 conversion trajectory and H2 hybrid heat pump trajectory.

* [0.5 hr] Main input files.

* [0.5 hr] Summary H2 file.

* [2 hr] Check deployment constraints for breaches. Is this a different process to the one I will have gone through to create the table pasted above? We have a process to check this within one of our working files; this is always done as a QA prior to running.

4. [0.5 hrs] Do 1 trajectory run.
5. [1 hr] Create new template.
 - * [0.5 hr] Repopulate input files.
 - * [0.5 hr] Create values version.
6. [1.25 hr] Post processing on template.
 - * [0.5 hr] DH reallocation from operational to investment costs – values and non-values.
 - * [0.25 hr] Emissions residuals check and finalisation.
 - * [0.5 hr] Energy efficiency check and reallocation.
7. [2.5 hr] Updating graphs and tables. I think if we go ahead it would be sensible for me to do some sense checks on how it has come out before we do graphs and tables for the report etc. Agreed.
 - * [0.25 hr] Trajectory analysis file and graphs.
 - * [0.25 hr] Reporting graphs.
 - * [2 hr] Update reporting graphs.

The above timeline accounts, based on task times, for a total of 10.25 hrs or roughly at least 1.5 days of effort. However, it does assume that everything goes according to plan, with limited additional requests and no additional QA. For clarity, we would apply the blended day rate from the original proposal which is £[fee redacted]/day excl. VAT. We would provide a fixed fee proposal for 1.5 days of effort, unless some of the stated additional pieces of effort (including the list below) need to be included or other discrete new tasks are identified partway through.

Current aspects which would be affected:

- * Fuel demand by type analysis:
 - * If this would need to be updated, this would add an additional 1.5 hrs for the file itself and any relating reporting graphs. Thanks we can think about whether we’d need this
- * HP uptake broken down by off- and on-grid:
 - * If this would need to be updated, this would add an additional 0.5 hrs. as above
- * Sensitivity outputs:

* As discussed, this would not require to be updated (and this is our preference as well). However, if this opinion changes, it would add an additional 1.5 hrs. Thanks for confirming

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Sent: 01 October 2020 17:31

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; Thompson, Mike <Mike.Thompson@theccc.org.uk>

Subject: RE: H2 hybrids in central

Hi [Name redacted]

Thanks for the summary – that all sounds consistent with what we were expecting following our discussion yesterday.

We will give some thought to what would be involved in the ‘targeted project extension’ option, keeping this as limited as possible in line with your steer, and come back to you shortly.

Best wishes

[Name redacted]

[Name redacted]

Associate Director

elementenergy

t: [Telephone number redacted]

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 01 October 2020 11:57

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@theccc.org.uk>; Thompson, Mike
<Mike.Thompson@theccc.org.uk>

Subject: H2 hybrids in central

Hi all,

Thanks very much for the chat yesterday on H2 hybrid heat pump deployment - I've just come out of the internal discussion on the topic.

The decision was that we will need to make a change, but that we have a couple of options for how to do it.

The change is essentially to remodel the H2 hybrid heat pump uptake in the central scenario only (i.e. no changes to the other scenarios, and no changes to pre-2030 trajectories or trajectories for any of the other heat pumps). The revised

trajectory would roll out H2 hybrid heat pumps as the grid decarbonises (i.e. if 10% of the grid on hydrogen at a certain point, then 10% of the H2 hybrid heat pumps are rolled out by that point). The assumption would also be that H2 hybrids move straight onto hydrogen at the point they are deployed.

The resulting deployment trajectory would look roughly as follows:

In terms of the options, we think they are the following:

1. RH to make an off model adjustment
 - a. I would effectively focus on deployment, fuel change, abatement, and investment costs and make off model adjustments to the templates you have provided
 - b. The idea would be to add a chart into the front of your report with the new trajectory which states that the CCC made a change to Element's central scenario
2. Element to make the change as part of a targeted project extension
 - c. The aim would be for the adjustment to be in model (such that we get a model at the end of the project which is consistent with the central scenario), but to make it as limited as possible
 - d. We think means changing the deployment profile for H2 hybrids (I can provide what I worked up as the basis), and then having the model flow this through to fuels, abatement and costs such that the charts can be updated
 - e. We were happy leaving scrappage costs as they are on the basis it will lead to some level of cost overestimate.
 - f. If we go with this approach, we are keen that as few of the wider modelling results change as possible, so I would be grateful for any thoughts on other things which might be inadvertently impacted which are not covered above.

Very grateful for thoughts, in particular the feasibility, timing and costs of any project extension of the type described in point 2.

Many thanks,

[Name redacted]

[Name redacted]

Lead Analyst - Buildings

Committee on Climate

Change<[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2F&data=02%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C3806a79d3021408c045008d869168484%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637374892723013700&sdata=u47PjMSlyQ0FbDToi2c0xF0qkAdPtKrysJfA7Gfp4hg%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.theccc.org.uk%2F&data=02%7C01%7C[Email address redacted]%40theccc.org.uk%7C3806a79d3021408c045008d869168484%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637374892723013700&sdata=u47PjMSlyQ0FbDToi2c0xF0qkAdPtKrysJfA7Gfp4hg%3D&reserved=0)>

[Telephone number redacted] |

@theCCCuk<[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=02%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C3806a79d3021408c045008d869168484%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637374892723013700&sdata=1OKdOCtN6dfjQAXKv2t5eXNyfoRYwu1EIVevKcCYFj4%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=02%7C01%7C[Email address redacted]%40theccc.org.uk%7C3806a79d3021408c045008d869168484%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637374892723013700&sdata=1OKdOCtN6dfjQAXKv2t5eXNyfoRYwu1EIVevKcCYFj4%3D&reserved=0)>

151 Buckingham Palace Rd, London SW1W 9SZ

From: [Name redacted]

Sent: 18 November 2020 18:50

To: [Name redacted]

Cc: [Name redacted]; [Name redacted]; [Name redacted]

Subject: RE: QA Update on Solid Walls

Attachments: Steering document for modelling v7.docx

Hi all,

Thanks very much for the quick responses – I am going to work them in now. To come back on a couple of points:

* Preheating

* I may be misunderstanding, but the description you have given of pre-heating is very different from the approach we had discussed (the brief was set out in the attached and the subsequent scenario guidance). Are you suggesting that we are assuming 25% of homes preheat in the balanced scenario and 50% of homes preheat in tailwinds? As I had understood and intended it the numbers would likely be much smaller (i.e. if only 50% of homes are post 1952, the proportions would have been 12% of all homes in central and 25% in tailwinds). I'd be grateful if you could clarify urgently as we are going to have to think what to do about presenting this if the modelling isn't aligned with the evidence here.

* District heat

* I am working in some of the previous wording you provided on how DH proportions are defined, is the following ok?

* We assume that the pace of deployment over the next five years is slower than in our fifth carbon budget scenarios, but similar to the fifth carbon budget, we assume that by 2050 around 18% of the stock is assigned to district heat (representing homes in areas of highest heat density).

* Cost of capital

* The response from Energiesprong has made me realise we have a 7.5% CoC for heat as a service which you generally would assume would apply to heating systems. However is this 7.5% also applied to energy efficiency in the relevant scenarios? If so this is likely very pessimistic and is something we should note in your report when discussing the high costs for innovation etc.

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Sent: 18 November 2020 17:53

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: QA Update on Solid Walls

Hi [Name redacted],

To confirm, the costs in the file you attached do not include the additional design/planning or scaffolding costs.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 18 November 2020 15:55

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: QA Update on Solid Walls

Hi [Name redacted],

To belatedly follow up on this for the purposes of drafting, I have taken a look at your updated file and added some workings to test the thresholds for what we ended up excluding. It looks like I could say something along the lines of the following:

We generally excluded measures from our economic potential where costs came in above £700/t for a typical home (assumed to be a medium semi-detached home). Some non-standard lofts and cavities were excluded on this basis. Our economic potential includes only the following non-standard categories: standard lofts with access issues, cavity walls in concrete dwellings, cavity walls with conservatories, narrow cavities, and high cavity walls.

I just wanted to check before finalising – do the solid wall costs in the attached include the additional costs for scaffolding etc or are they excluded?

[Annex G]

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Sent: 21 October 2020 12:44

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: QA Update on Solid Walls

Hi [Name redacted],

Thanks for the notes. Please see our in-line comments below.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: 19 October 2020 16:10

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Subject: FW: QA Update on Solid Walls

Hi [Name redacted],

I'll need to refer to some past emails in some of the comments on the slides, so I'm going to send the relevant emails through separately where helpful.

One comment I am making is about the EE £/t you are reporting in the write up; you report £/t for a medium terraced house but the numbers are quite a lot higher than those we had been discussing in the course of the development as below.

* To clarify, much has changed since the v5 of the file that you attached in the below email (e.g. that file had incorrectly applied package uplift factors to inflate savings and thus lower £/t values); as such, the numbers being used in the actual modelling do not reflect that file. For reference, please find the latest update of the file attached (v8) which is a better representation. However, we can be assured that the model itself does include the correct numbers; the actual model and the analysis files are not interdependent.

* Additionally, the numbers used to formulate packages were simple averages across type and size whereas the graph in the report is an illustrative example of just one type and size (we can make sure this is clear in the report).

* In actual modelling, we forced package uptake on an specific archetype level so that all packages under 600£/t are included, which is aligned to the guidance and our agreed process.

I think the £/t need to come out in the report in two places. The first is in comparison to the 5CB £/t (see table 10 on p64 here:
<https://www.theccc.org.uk/wp-content/uploads/2013/12/Review-of-potential-for-carbon-savings-from-residential-energy-efficiency-Final-report-A-160114.pdf>
<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2F>

www.theccc.org.uk%2Fwp-content%2Fuploads%2F2013%2F12%2FReview-of-potential-for-carbon-savings-from-residential-energy-efficiency-Final-report-A-160114.pdf&data=04%7C01%7C[Email address redacted]%40theccc.org.uk%7C772151d16b164bd8efe008d88beac54c%7C770a245002274c6290c74e38537f1102%7C1%7C1%7C637413188192339856%7CUnknown%7CTWFpbGZsb3d8eyJWljojMC4wLjAwMDAiLCJQljojV2luMzliLCJBTil6lk1haWwILCJXVCi6Mn0%3D%7C1000&sdata=%2Bz3ezp%2B1mnQhuQugMlm%2F0I%2B5V8psK4gL5Z6FQRL0NOA%3D&reserved=0>). I am imagining for this purpose we could try to get a comparable metric by dividing e.g. total costs by total abatement for each measure to get a weighted average.

* To confirm, were you thinking of a comparison using (1) table 10 of the above and (2) numbers based on our template? If so, please see the comments below and confirm if you would be happy with an overall cost comparison of £/t; Cavity wall, floor, other, roof, solid wall; on the higher level basis. The other option is to use the numbers from the attached analysis to replace (2) with more granular £/t numbers for specific measures.

* E.g.

£/t; £/t; £/t;

* Regarding the template numbers, a simple costs over abatement does not work as the £/t we use accounts for opex savings, lifetime, etc. in an overall PMT calculation. Additionally, if we are using the template data, we do not have granularity of the measure types beyond the below listing (e.g. the differentiation between ETT CWI and HTT CWI is merged to just Cavity Wall). However, a quick high level analysis on Central template gives the below:

Measure	Deployment (M)	MtCO ₂	Cost (£m)	Yearly opex savings (£m)
---------	----------------	-------------------	-----------	--------------------------

Cavity wall	3.09	0.656	3,530	120	31.89
-------------	------	-------	-------	-----	-------

Floor	3.44	0.688	10,833	120	455.19
-------	------	-------	--------	-----	--------

Other	28.30	1.402	10,333	247	118.64
-------	-------	-------	--------	-----	--------

Roof	10.84	1.048	5,284	178	31.46
------	-------	-------	-------	-----	-------

Solid wall	3.37	1.196	25,124	220	656.11
------------	------	-------	--------	-----	--------

The second place we need to mention them is in relation to explaining how we have determined the packages.

* Agreed.

Essentially the way we ended up deciding on which measures to include was those which came in under £600/t on an individual measure basis, and similarly when I was determining which HTT lofts and cavities, I looked for those which came out at under £600/t on the same basis (I used the attached spreadsheet to generate these). We'll need to explain that this was the approach that was taken to inclusion.

Ideally the weighted averages you calculate for the purpose above would fit with this, but if they are coming out over £600/t we can have another cut which shows something closer to what we used to determine the packages.

* As mentioned above, in actual modelling, we forced package uptake on an specific archetype level so that all packages under 600£/t are included. This was done in EE package selection step by identifying the cost optimal EE uptake and upgrading them where needed to impose the additional <£600/t packages. Therefore, if applicable to the package, as an example, a solid wall could have been 700 £/t and a loft 200 £/t; but the overall package £/t could be lower than 600£/t and so forced.

* We can include some notes on this in the reporting.

I've attached the spreadsheet I used to generate the nos below ; I can't seem to quite recreate the exact nos below using the analysis tab, but I can get nos which remain aligned with the ;under £600/t criteria;. I took the below from the ;average; column but equally open to e.g. using a M semi detached as our typical home or some other approach.

Not sure I've explained that as clearly as I might have done but just give me a call if helpful to talk through.

Thanks,

[Name redacted]

From: [Name redacted]

Sent: 28 May 2020 12:10

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: QA Update on Solid Walls

Hi [Name redacted],

Thanks for updating me. Grateful if you could prioritise my email on trajectory dates at this stage, but I've set out some quick responses on the below that I'd be grateful for thoughts on later on when you have time:

Am I right in thinking this is the latest ranking with £/t?

If so, then the updates below don't necessitate alteration of the packages. Solid floor insulation still remains above the cost of IWI so it isn't logically inconsistent to keep the packages as they are; the main change is that our packages look at measures under £800/t rather than £600/t.

In terms of our forcing, we are forcing in measures for FP homes. Other than that it sounds like we are still being consistent in forcing all lofts and cavities (and these all come under £600/t) and forcing in walls that are also under £600/t when taking the full costs into account. Is that correct?

I think the highlighted below is the key point and essentially is a question of whether we'd want to put all solid walls in high and then do a cost curve against both EWI and IWI. Agree it then becomes a question of whether this is something we have appetite to do given the time penalty. Grateful for an estimate of how long it would take. I am also conscious it would throw out our formulation approach for engaged people which would be problematic at this stage.

Thanks,

[Name redacted]

From: [Name redacted] [mailto:[Email address redacted]]@element-energy.co.uk]

Sent: 28 May 2020 11:44

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>; [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: QA Update on Solid Walls

Hi [Name redacted],

While updating and QAing the recent changes in the EE Cost and Savings model, we believe we have found out why solid walls were not being taken up cost effectively in the alternative scenarios. Apologies for not finding this earlier, but it is because solid walls (even with TIWI) have the required ‘scaffolding’ and/or ‘survey and design’ costs added to them. This is something we agreed much earlier on in the project (“supplementary costs”) and something we have not looked into since. The good news is that the model is functioning correctly, adding in these costs when required:

- * ISWI needs an additional ~£1350 for survey and design.
- * ESWI needs and additional ~£2150 (~£1350 + ~£800) for survey and design and scaffolding.

However, when formulating the off-model £/t analysis file that we then used to formulate our packages, the above costs were not taken into account. We have been thinking that these measures are more cost effective than they actually are. As such, there is the potential that ISWI does not actually belong in the medium package (see below).

New Measure £/t	Before supplementary costs added	After supplementary costs added
-----------------	----------------------------------	---------------------------------

ESWI

(currently high) £ 557 £ 780

ISWI

(currently medium) £ 371 £ 532

Acknowledging that ISWI is already in the medium package and looking at our recent forcing decisions based on the £600/t threshold, these calculations did account for the full ISWI cost. The number of ISWI that we are forcing in central is in fact only in archetypes that are cost effective ($\leq$ £600/t). Although this does potentially mean we should actually be forcing High and therefore the outcome would be slightly different, we do not expect a big change in the number of solid walls in packages under £600/t as the high package outcome will not be too different from the Medium. Max is unaffected as we force High anyway.

Regarding the alternative scenarios, when we get to re-running these, we may want to include ISWI in the high package (along with ESWI) or develop another solution with this knowledge in mind.

Since returning to update the £600/t cost curve analysis for High packages and then refining the number of packages to force in each scenario is likely to be quite time consuming for what we expect to be relatively minor changes, it would be good to discuss the timing of this update given the time constraints this week.

We wanted to flag this to you; let us know what your thoughts are when you can.

Regards,

[Name redacted]

[Name redacted]

Consultant

elementenergy

t: [Telephone number redacted]

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From: [Name redacted]

Sent: 04 February 2021 15:53

To: [Name redacted]; [Name redacted]

Subject: FW: HPA High Temperature Heat Pump Data

Follow Up Flag: Follow up

Flag Status: Flagged

Copying you in for sight

From: [Name redacted]- Ecuity <[Email address redacted]@ecuity.com>;

Sent: 04 February 2021 15:51

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: HPA High Temperature Heat Pump Data

Hi [Name redacted],

Few comments on the below highlighted. Please let me know if you have any follow ups.

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 04 February 2021 14:58

To: [Name redacted]- Ecuity <[Email address redacted]@ecuity.com>
<mailto:[Email address redacted]@ecuity.com>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: HPA High Temperature Heat Pump Data

Thanks [Name redacted], that's great and we can reference as you suggest.

As it happens I did have one quick sense check you may be able to help with. We're just finalising some of the write up of the work and need to include a summary of the space requirements of heat pumps. At the moment we have the following:

- * Monobloc ASHP – require outdoor unit only and a hot water tank or heat battery

- * Split ASHPs generally require an indoor unit, an outdoor unit and a hot water tank or heat battery.

- * GSHPs generally require a single unit which can be installed indoors or outdoors and a hot water tank or heat battery; this is in addition to the ground loop.

- * GSHPs are assumed to have higher suitability in internally space constrained homes compared to ASHPs, due to greater flexibility over the placement of the unit, which can inside or outside. This is not true – as the monobloc ashp require outdoor unit only.

- * I would say instead “Both ASHP and GSHP offer flexibility with internal space constrained homes depending on which solution is chosen”

Clearly configurations can differ between sites and manufacturers – I know some GSHPs integrate the hot water store into the heat pump unit for instance and I read that Viessmann are now selling an ASHP with the indoor unit integrated into the outdoor unit. Is the above summary a fair generalisation for common configurations though would you say?

Many thanks,

[Name redacted]

From: [Name redacted]- Ecuity <[Email address redacted]@ecuity.com<mailto:[Email address redacted]@ecuity.com>>

Sent: 04 February 2021 14:34

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: HPA High Temperature Heat Pump Data

Hi [Name redacted],

Yes, more than happy for the graphs to be used and glad that they've been useful. Please could you reference them as 'Heat Pump Association Data' if that fits in with your referencing system?

Also, more than happy to help out in anyway possible in regards to ongoing or future data needs, please do reach out if you think we might be able to help with anything.

Kind regards,

[Name redacted]

[Name redacted]

Senior Economic Analyst

Ecuity, a

Gemserv<[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgemserv.com%2F&data=04%7C01%7C\[Email address redacted\]%40theccc.org.uk%7Cefb53ad4dac447dbd25b08d8c924b232%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480506747385109%7CUnknown%7CTWFpbGZsb3d8eyJWljojMC4wLjAwMDAiLCJQljojV2luMzliLCJBtil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=POAVco08%2F0GxSnxO89ed6g2l4Lw1yykafywd7%2F7PKCs%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fgemserv.com%2F&data=04%7C01%7C[Email address redacted]%40theccc.org.uk%7Cefb53ad4dac447dbd25b08d8c924b232%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480506747385109%7CUnknown%7CTWFpbGZsb3d8eyJWljojMC4wLjAwMDAiLCJQljojV2luMzliLCJBtil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=POAVco08%2F0GxSnxO89ed6g2l4Lw1yykafywd7%2F7PKCs%3D&reserved=0)> Ltd company

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href="https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.linkedin.com%2Fcompany%2Fecuity-consulting%2F&data=04%7C01%7C[Email address redacted]%40theccc.org.uk%7C9c85b1fc4b7d4e489da808d8c919f10b%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480460579190809%7CUnknown%7CTWFpbGZsb3d8eyJWljiMC4wLjAwMDAiLCJQIjoiV2luMzliLCJBTil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&data=k5kGyd%2Bo2o07bquaCYfKzyMUx1dr8%2F9lgnorajqnBLE%3D&reserved=0<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.linkedin.com%2Fcompany%2Fecuity-consulting%2F&data=04%7C01%7C[Email address redacted]%40theccc.org.uk%7Cefb53ad4dac447dbd25b08d8c924b232%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480506747415093%7CUnknown%7CTWFpbGZsb3d8eyJWljiMC4wLjAwMDAiLCJQIjoiV2luMzliLCJBTil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=Wyr4XwhCkepFwvmG2LvagBZvdFTEoff%2BB2JE33%2BEBZw%3D&reserved=0>" style='position:absolute;margin-left:38.3pt;margin-top:9.05pt;width:17.9pt;height:17.9pt;z-index:251666432;visibility:visible;mso-wrap-style:square;mso-width-percent:0;mso-height-percent:0;mso-wrap-distance-left:9pt;mso-wrap-distance-top:0;mso-wrap-distance-right:9pt;mso-wrap-distance-bottom:0;mso-position-horizontal:absolute;mso-position-horizontal-relative:text;mso-position-vertical:absolute;mso-position-vertical-relative:text;mso-width-percent:0;mso-height-percent:0;mso-width-relative:page;mso-height-relative:page'
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<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fuk.linkedin.com%2Fin%2Flaurablaj&data=04%7C01%7C[Email address redacted]%40theccc.org.uk%7Cefb53ad4dac447dbd25b08d8c924b232%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480506747415093%7CUnknown%7CTWFpbGZsb3d8eyJWljiMC4wLjAwMDAiLCJQIjoiV2luMzliLCJBTil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=qHxbPIM8FtwN0fn0UKRc9%2FMwkhAo%2FiBNqrjPDhtRmPo%3D&reserved=0>

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From: [Name redacted] <[Email address redacted]@theccc.org.uk> <mailto:[Email address redacted]@theccc.org.uk>

Sent: 03 February 2021 16:46

To: [Name redacted]- Ecuity <[Email address redacted]@ecuity.com> <mailto:[Email address redacted]@ecuity.com>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk> <mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: HPA High Temperature Heat Pump Data

Hi [Name redacted],

I hope you are well and that you had a lovely Christmas and new year, if it isn't still too late to be saying that!

A somewhat belated follow-up on the below. Element Energy are currently finalising their full report on the sixth carbon budget analysis and we'd really like to include the charts you provided below in an annex to help illustrate the value of high temperature heat pumps. Is this something you would be comfortable with?

If so, I'd also be grateful for a steer on how you'd like us to reference it.

Many thanks,

[Name redacted]

From: [Name redacted]- Ecuity <[Email address redacted]@ecuity.com> <mailto:[Email address redacted]@ecuity.com>

Sent: 30 July 2020 13:24

To: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Subject: HPA High Temperature Heat Pump Data

Hi [Name redacted],

Hope that you are well. [Name redacted] asked me to collect data from the HPA membership on High Temp. (HT) HP performance, I understand that you are looking to establish performance under extreme cold spells in particular. The attached spreadsheet also contains the data described below, please let me know if you have any follow up questions at all, I'm happy to help.

[Annex H]

Most manufacturers were only able to provide me with the data of HT HPs under average climatic conditions, please see the summary graph below for this for 60-65degC flow temps.

One manufacturer was also able to provide me with graphs of how performance and capacity vary according to the external temperature for their HT HP. I hope that these are of particular use, please see below.

Kind regards,

[Name redacted]

[Name redacted]

Economic Analyst

Tel: [Phone number redacted]

[Phone number redacted]

[Email address redacted]@ecuity.com<mailto:[Email address redacted]@ecuity.com> ?
www.ecuity.com<https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Flinkprotect.cudasvc.com%2Furl%3Fa%3Dhttp%253a%252f%252fwww.ecuity.com%252f%26c%3DE%2C1%2CiSGJFBR42x4KLXPXjKPHZiC1VYBxtLXREXptl536fc2SsaVGJjiW32jil8tVyHSw-zs2JfkTNMTY1DRc5e9ovk8neBys_UBVeDfemOfkH2Avi9U_8Lf5nr-NZfzbl%26typo%3D1&data=04%7C01%7C[Email address redacted]40theccc.org.uk%7Cefb53ad4dac447dbd25b08d8c924b232%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480506747425086%7CUnkown%7CTWFpbGZsb3d8eyJWlloiMC4wLjAwMDAiLCJQIjoiV2luMzliLCJBtil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=G9g25upj%2Bsl0X0PKyG4H5SJLQm7ZdoWrcFlR8dmPJW8%3D&reserved=0>

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www.linkedin.com/in/[Name redacted]--69717576<https://eur03.safelinks.protection.outlook.com/?url=http%3A%2F%2Fwww.linkedin.com%2Fin%2F[Name redacted]--69717576&data=04%7C01%7C[Email address redacted]40theccc.org.uk%7Cefb53ad4dac447dbd25b08d8c924b232%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637480506747435081%7CUnkown%7CTWFpbGZsb3d8eyJWlloiMC4wLjAwMDAiLCJQIjoiV2luMzliLCJBtil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=J68OXGbwvV%2BC9ZVTcpAamOutGPZUPInu p8WZDA5V20Q%3D&reserved=0>

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From: [Name redacted]
Sent: 30 March 2021 13:24
To: '[Name redacted]'
Cc: '[Name redacted]'; '[Name redacted]'
Subject: RE: Timetables for finalising 6CB work.
Attachments: RE: GWP issue

Follow Up Flag: Follow up
Flag Status: Flagged

Categories: have read - might be useful

Hi [Name redacted],

Many thanks for this and apologies I am replying a bit later today than intended – I failed to realise yesterday I had a full morning of meetings. I have added a few responses in line below.

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
Sent: 26 March 2021 12:26
To: [Name redacted] <[Email address redacted]@theccc.org.uk>;
Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

The assumption log has now been cleaned (please see v25 attached; you will also find this in the shared folder). Please find the below notes in response to the comments posed in the log itself:

BioLPG price mismatch

* This could not be traced back to any of the previous versions of the Prices Workbook we have. The difference between the prices in the log and those in the workbook is at most 0.2%, and less than 0.001% for most years; as such, the effect on modelling results is minimal. We have kept (in the log) the numbers used in the modelling for accuracy and alignment with results.

Understood

Emissions units for electricity

* Whilst non-CO2 indirect emissions for hydrogen were not accounted for, those for electricity were included. Hence, the unit for those lines has been noted as kgCO2e/kWh. The same applies for Heat networks fuels derived from electricity.

I altered the phrasing slightly in my last version as I thought it described the definitions more simply (given elec non-Co2 assumed nil), but I don't feel strongly and am fine with your reversion. Lets stick with what we have.

Biomass CH4 emissions

* The figures in the assumptions log match the penultimate version of the prices workbook (the 18/06) version, and all previous versions. It may have been that the update was not flagged when the latest prices workbook (28/07) was shared, which led to the values not being updated. The difference between the two versions is a factor of 10 so is unfortunately not negligible when considered in isolation. It should however have a minimal impact on the overall results as biomass is not used as a fuel for any of our renewable technologies. We have kept (in the log) the numbers used in the modelling for accuracy and alignment with results.

I've had a look back at emails and I think the attached is the most relevant. It seems [Name redacted] confirmed that the alteration in the assumptions here would have no impact as not used, on this basis are you happy to include the corrected nos in the assumptions log? (If preferred we can include a note to the effect they weren't used directly)

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: Wednesday, March 24, 2021 2:42 PM

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Thanks very much [Name redacted].

I am still a bit confused on the final point. In '6CB Assumptions Log' rows 69 and 70 are labelled kgCO₂, but are drawn from columns AH43 and AI43 of DH v5.4 which is labelled kgCO_{2e}. What is the correct labelling for these, should it be CO₂ or CO_{2e} (i.e. are any other gases included in these nos other than CO₂)?

Given your answers, I think the labels need a few more edits which I've added in red. See comments in attached for cells relevant to queries above and 3 additional areas where there seem to be discrepancies. Hopefully this will be everything and we can then get it up on the website.

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Sent: 22 March 2021 18:39

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Please find attached the now finalised log and latest DH file (both of these can be found in the shared folder as well). The log is now also cleaned (comments deleted, unnecessary tabs removed, and turned all red text black). Please see our in-line comments in response to your email below.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: Friday, March 19, 2021 3:33 PM

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk

[Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

A few responses below on the assumptions log.

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Sent: 18 March 2021 19:22

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Please find attached the latest report (all comments addressed, including updating the Balanced Pathway scrappage analysis to account for the latest H2 deployment/trajectories) and updated assumptions log (with some remaining comments).

Regarding the log, we have addressed the majority of the comments on the fuel costs and CO2 tab and made the necessary changes. There is one item left concerning the emissions tables:

* The CO₂ intensity table (rows 52-78) is meant to have figures in kgCO₂/kWh, not CO₂e. The numbers in the table are sourced from the Carbon intensities table in the Prices workbook (row 131 onward for Central), rather than the Emissions intensities table (row 177 onward). This is why CO₂ and not CO₂e is used as the unit. Previously neither was listed as the unit (it just said 'kg/kWh') which is what led to my trying to make explicit and the subsequent confusion. Understood. It also explains the discrepancy in hydrogen emissions that you noted.

* We assumed that the Emissions intensities table is populated by summing the values in the 3 tables above it (Carbon intensities, CH₄ emissions & N₂O emissions). This is true for Gas, for example. This then implies that electricity emissions are all due to indirect CO₂, with no contribution from CH₄ or N₂O, hence the zero values in the Fuel costs and CO₂ tab. No, that is only the case for direct. For indirect we just had emissions intensity and didn't separate out N₂O and CH₄. Noted.

* If (as your comments state), the above assumption is incorrect and the emissions quoted in the prices workbook for electricity under the Carbon intensities table in fact include CH₄ and N₂O, then we can amend the assumptions log accordingly. The rows labelled 'Carbon intensities (gCO₂/kWh) do not include CH₄ and N₂O, they are CO₂ only. However, the rows labelled 'Emissions intensities (gCO₂e/kWh) do include CH₄ and N₂O.

So have you used the hydrogen CO₂ intensity only (rather than the emissions intensity) in the modelling on that basis? Correct. If so I think overall this will lead to an underestimate in the reported indirect emissions in the templates. Correct I suggest that we include carbon intensity (kg CO₂/kWh) in the assumptions log given this is what you used, but add a note to explain these assumptions exclude some non-co₂ emissions and will be a small underestimate on that basis. We have kept your initial correction where the table in the log has kgCO₂e/kWh for electricity and kgCO₂/kWh for all other fuels. Notes have been added to explain the underestimate for Hydrogen and Heat fuels (see cells AV64:AV76 and P115). There is no underestimate for electricity based on the numbers in the Prices Workbook. I understand you have not used hydrogen 'dedicated SMR+CCS' rows for CH₄ and N₂O, which is the right thing to have done. Correct.

* If you can confirm this point regarding the prices workbook, we can finalise the assumptions.

Can I also check, your DH 5.4 file that I used to draw the Heat 'gas to hydrogen peaking emissions from has the labels 'Direct CO₂ (kgCO₂e/kWh) and 'Indirect CO₂ (kgCO₂e/kWh). Should the units here actually be CO₂ rather than CO₂e, as they only contain CO₂? The units are actually correct, since the file has separate columns for direct and indirect CH₄ and N₂O. There is some confusion due to the presence of separate columns for indirect CH₄ and N₂O emissions columns, when in fact those contributions are embedded in the indirect CO₂ emissions column. It also remains that the non-CO₂ indirect emissions from hydrogen have not been accounted for. We have deleted the redundant columns to make things clearer and corrected the CH₄ and N₂O direct emissions figures (updated file attached).

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: Wednesday, March 17, 2021 5:24 PM

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi all,

Many thanks for all the hard work getting the slides finalised. I have now finished going through with some final amendments in red (you can find them by searching through the comments). Great if you could accept and turn black if happy.

There are also a few very brief remaining questions on slides 124, 225, 245 and 256 in response to your replies.

I have also now been through the updated assumptions log you provided me with on 25/01/21. I mentioned that I might propose a few additional updates to the fuel costs and CO2 tab at the same time as it has still generated questions from people struggling to follow it. I can see why the confusion is arising so have

made a number of suggested amendments in the attached I would be grateful if you could review and accept if happy:

- * Rather than having unused heat network nos in the tables I have streamlined to only include those used
- * For headwinds I am suggesting we include the nos for gas to hydrogen peaking so that readers can understand directly what was used
- * The CO2 intensities were a mix of Co2 and Co2e and were unlabelled, I have tried to label but please do check correct
- * The hydrogen CO2e intensity doesn't match the assumptions log so wondering if there is a small error here?
- * For CH4 and N2O I have clarified that we only have these for direct emissions and have deleted the values for electricity and hydrogen (which are misleading as they show 0, when in fact they may be non-zero but just subsumed into the CO2e values above)
- * I have updated the note in D201 as agreed

You can see I have added the two source tabs upfront for the purposes of suggesting the nos I understand to be correct, once checked these can be deleted. The 'headwinds' tab is from 'DH v5.4' and the 'prices for modelling' tab is from 'Prices workbook 2019 v5 280720 change log'.

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 15 March 2021 17:20

To: [Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Yes that amendment is correct; thank you for updating that off the back of our finalisation.

Also, a bit pedantic, but the first added red bullet is missing a full stop (“.”).

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk<mailto:[Email address redacted]@theccc.org.uk>>

Sent: Monday, March 15, 2021 2:43 PM

To: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>;
[Name redacted] <[Email address redacted]@element-energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>>

Subject: RE: Timetables for finalising 6CB work.

Thanks [Name redacted], I am just going through the final slides now and have edited as follows:

Is this drafting now correct? I understand the 41 degrees is for space heat only, rather than itself being a weighted average which somehow includes the hot water temperature?

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Sent: 08 March 2021 18:26

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Thank you, I did – got to enjoy some of the sun and nice weather (via a long walk). Hope you did as well.

Not a problem on the timeline, that sounds good. Regarding the average flow temperature, yes we would expect that the temperature be higher for hybrids and so increase the overall weighted average slightly.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
[Email address redacted]@theccc.org.uk

Sent: Monday, March 8, 2021 9:09 AM

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Hope you had a nice weekend. Thanks re: the timeline, I'll aim to go through the pack next week in that case.

On flow temperature, am I right in understanding then that the average flow temperature is likely then to be slightly higher than 41 degrees overall, given that the average doesn't include hybrids which would be expected to operate at higher temperatures?

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
[Email address redacted]@element-energy.co.uk

Sent: 05 March 2021 16:41

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Not a problem – thank you for your reply and update on this. The plan sounds sensible and considering I do not foresee any issues regarding your proposed timeline, particularly as there are no outstanding actions on our end.

Regarding the flow temperature query, I have just double checked our previous flow temperature analysis and the weighted average flow temperature for pure ASHPs (between the two variants) in the Balanced Pathway is ~41C. As such, please feel free to clarify that in the report directly.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Sent: 04 March 2021 16:18

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Email address redacted]@element-energy.co.uk

[Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Sorry it's taken me a bit of time to get back to you, thanks for your patience. In terms of the actions on my list for finalising, I need to:

- * Go through the final pack (from a quick skim the responses you have provided are very helpful for understanding the updates so thank you for that)
- * Add in the outstanding responses from external stakeholders
- * Go through the assumptions log and propose some final changes to the LRVs sheet, as we identified there were a few errors/confusing features there

I have a number of other pressing things next week, would it be ok if I aim to complete the above in the w/c the 15th March? Would this cause any issues from your perspective?

I've had a quick look through some of the slides in the first instance and there are some extremely helpful clarifications in there so thank you. A quick question on flow temperature, you note in the slide that it is an average of 40 degrees for hybrid systems, and in the comments you suggest that 40 degrees is the average (for all systems?). Helpful to just confirm which is the case – am I right in thinking the flow temp in pure heat pumps would generally be expected to be lower than for hybrids. This means that if BEIS assume an average of 40 degrees, then our average across the stock is likely to be lower than this?

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 02 March 2021 10:06

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
energy.co.uk<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Timetables for finalising 6CB work.

Many thanks [Name redacted], that is much appreciated. I will take a look (likely on Thurs due to some immediate deadlines) and get back to you on timings as soon as I can following,

Best wishes,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 26 February 2021 11:26

To: [Name redacted] <[Email address redacted]@theccc.org.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Thank you again for going through the slides in such detail and providing readily actionable feedback. Please find attached the latest slide packs (equivalent apart from comments): v24 includes all comments and responses (for your reading and reference), and v25 has comments removed (apart from slides 105, 112, and 145 where you are awaiting external feedback; for finalising).

Though the level of commentary, and resulting additional effort/analysis required, was more than we were initially expecting, we still aimed to address, resolve, and account for all the high-impact notes to ensure the final set of slides are thorough and comprehensive. Your detailed suggestions and targeted questions were helpful towards this end. Feel free to go through the final pack

and please do let us know when you are able to finalise the remaining three slides/references and when the pack will be published online.

We are all very excited that this extensive, high-impact piece of work will be published and available soon.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>

Sent: 15 February 2021 16:24

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

In relation to the point about fuel bill comparisons with EPC ratings I don't think we need a full slide on this but suggest that on slide 226 we add something like the following caveat at the bottom, if you agree:

'The fuel bill assessments resulting from this analysis will differ from those which might result from using the SAP/BREDEM methodology and so cannot be

directly compared. In particular this analysis uses different assumptions for baseline heat demands and savings associated with measures (containing also only a subset of the measures which are included in SAP); it incorporates fuel use associated with lighting and appliances based on ECUK (whilst SAP ratings are based on energy costs associated with space heating, water heating, ventilation and lighting only); and it is based on CCC retail price projections (rather than SAP fuel prices and standing charges). The fuel bill assessments in the following slides have been undertaken for 2050 only and different profiles would be expected over the course of the trajectory.

In relation to the appendix slides, please find a few additional comments in the attached.

I am still waiting to hear back on the outstanding queries for slide 114 and 146 as mentioned below. I have chased again today.

Many thanks,

[Name redacted]

From: [Name redacted]

Sent: 11 February 2021 18:47

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Email address redacted]@element-energy.co.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Thanks very much for your understanding on the delay in getting the second half of the comments to you. I have now been through and taken the same approach in suggesting edits/leaving comments on the second half of the

slidepack (see slides 158 onwards in the attached – comments on the first half not included so please look at previous version for this).

These are lighter than for the first half, with some of the more substantive comments being that:

- It would be good to add in a couple of additional stats in places e.g. on total costs for scenarios (which we have been asked about and is good to be clear on for transparency and policy purposes), and heat network heat demands
- There are a couple of areas where it would be really valuable to be able to explain the modelling deployment further, particularly why Scotland is getting so many GSHPs and also what about a home makes it a candidate for more cost effective SWI
- You will see that I have suggested expanded drafting on the limitations and further work section, building also on the write up of this in the 6CB report. Apart from reviewing my suggestions here, it would be great if you could take a look at the comment on network data needs - Ofgem asked us to include in this write up for the purposes of what they are likely to commission in the future and I don't think I am clear from the current write up what is needed.

I am happy to have a bit of a think about the slide on EPC equivalence but have not yet had a chance to do so, and I have also realised I haven't been through the appendix. I am working 4 day weeks now so am off tomorrow but should be able to take a look on Monday – hopefully this won't create any hold ups given you've got all the comments on the main slide pack now.

Many thanks and have a lovely weekend,

[Name redacted]

From: [Name redacted]

Sent: 08 February 2021 17:58

To: [Name redacted] <[Email address redacted]@element-energy.co.uk><[Email address redacted]@element-energy.co.uk>>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@theccc.org.uk>;

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Please find attached some suggested changes and final comments up to slide 158 in the attached.

It is very nearly there I think so thanks for all the hard work on it!

A general comment is that there remain a lot of acronyms that aren't really needed and will make it harder for people to read (especially those less familiar with the topic area) ; grateful if you could just do find and replace to use the full terms where possible (e.g. heat pump, Fifth Carbon Budget, Sixth Carbon Budget).

As discussed, I have added some edits in red so hopefully largely a case of turning the red text black after you have checked it/if you agree with it.

There are also a few areas where there remain comments for you to address. A quick summary of the key ones:

* Slide 73 ; I haven't been able to find an explanation of the capital costs associated with behaviour change either in the assumptions log or slidepack, so grateful if we could add (I have to do a presentation on behaviour change on Wednesday so would appreciate a quick answer on this if possible)

* Slide 81 ; We don't have an explanation anywhere I don't think about what we assumed re: the split of IWI and EWI and what the model actually deployed. I seem to remember that our approach of deploying SWI where under £600/t led to IWI being dominant (or exclusively deployed?). I think we need to be explicit about this as we've had criticism from a few avenues on our energy efficiency costs being too low particularly for solid wall. I think valuable to be transparent on what has been costed and assumed here, and what the uncertainty is (i.e. explaining that even if we have assumed IWI dominant this may well not be the case in reality and costs may therefore be an underestimate).

* Slide 113 and 129 – I found the slides lacking in some of the detail on the approach for low carbon heat networks so I have tried to add in as far as possible, keen we are as comprehensive and transparent as we can be in our write up of this

* Slide 118 – The slide on radiator sizing is unfinished - this is a particularly important one to be transparent about as we know there is uncertainty associated and I am conscious that some of the assumptions here could have quite a material impact on the results. As well as an explanation of how the model applies radiator upgrades, can we please include on this slide or elsewhere a summary of the average flow temperatures assumed across the scenarios and acknowledge that fewer upgrades would lead to higher flow temps, lower efficiency and more electricity consumption etc?

* Slide 124 – I'm still not clear from this slide or the assumptions log what the fuse limit constraint is in quantitative terms? We are getting asked a lot of questions on the suitability of heat pumps in homes which have uninsulated solid walls and [Name redacted] has asked that we make sure we have a clear story (in this slide or elsewhere) on what happens to these homes. Do they still get heat pumps but just cost more to run (this is what the slide seems to imply) or do they get other solutions?

* Slide 128 – I am struggling to reconcile some of the descriptions of costs here with my understanding/the approach set out in the guidance. I wonder if perhaps the slide as it is currently is trying to summarise some other cost categories you used internally rather than those used for reporting?

There are also a few areas where I am still waiting on responses from others:

* Slide 114 – I have chased Hy4heat on the reference and am waiting to hear back

* Slide 146 – I am checking with the Welsh Govt on the reference to their policy position as their published statements on this are somewhat vague

I am desperately trying to free up my diary to suggest final changes to the remainder of the slides and had hoped to focus on it today and tomorrow, but unfortunately have been facing a somewhat unrelenting onslaught of qs on the scenarios with short deadlines (most recently the Environmental Audit Committee and Scottish and Welsh Govts), I've also just been asked to be on the panel for a 600 person event on behaviour change for the 6CB on Wednesday which I need to do some prep for in the couple of hours of desk time I have tomorrow, so I can explain and answer questions on our scenarios. Unfortunately I think I am really going to struggle to get you the remaining slides early this week as a result. Would it cause a problem if I aim for the end of the week instead? Happy to discuss any knock on deadline impacts if needed and sorry about this. The bright side is that the high levels of interest in the work don't seem to be dying down;

All the best,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;

Sent: 05 February 2021 15:29

To: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>
<mailto:[Email address redacted]@element-energy.co.uk>;

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Thanks for the update. As you suggest, Monday will be fine.

Have a great weekend.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>
<mailto:[Email address redacted]@theccc.org.uk>;

Sent: 05 February 2021 15:27

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Timetables for finalising 6CB work.

Thanks [Name redacted], I am just waiting on a couple more inputs for my suggested edits up to slide 158 and should hopefully have them so I can send on Monday (I could share what I have now but imagine you'd rather avoid version control confusion).

I will aim to get the remaining slides back to you as early as possible next week.

Many thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>;

Sent: 04 February 2021 10:55

To: [Name redacted] <[Email address redacted]@theccc.org.uk>;

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

To confirm, no changes have been made prior to slide 158 and so please do feel free to continue on the version you have for the non-results slides.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>

Sent: 04 February 2021 10:02

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Thanks for this, can I just check if any changes have been made prior to slide 158? I am half way through suggested edits to the preceeding slides on the v20 version, so am I ok to keep working on that for the non-results slides?

Thanks,

[Name redacted]

From: [Name redacted] <[Email address redacted]@element-energy.co.uk>

Sent: 03 February 2021 19:05

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Email address redacted]@theccc.org.uk

Cc: [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

As discussed, please find attached the completed draft of the report (including the remaining 'second half' not sent in the previously sent slides). The slides from slide 158 onward are most relevant for your final overview, consisting of the updated content (based on your previous feedback).

As noted in my email below, we can plan to make minor updates (if necessary) based on your final set of feedback. If possible, could you please provide any final updates/comments (including slides that have been suggested for you to draft) by the start of week.

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted]

Sent: 27 January 2021 15:02

To: [Name redacted] <[Email address redacted]@theccc.org.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>; [Name redacted] <[Email address redacted]@element-energy.co.uk>

Subject: RE: Timetables for finalising 6CB work.

Hi [Name redacted],

Thanks for updating us on this. Yes, we agree that we can work towards completing the remaining items (report + model handover + invoicing) for this project by the end of Feb as a firm deadline.

Regarding the report, we will send you the updated slides for the remaining half of the report early next week for your final high-level review. Additionally, we can plan to make minor updates (if necessary) based on your final set of feedback when you get back to us (ideally all comments by the end of next week if possible). As discussed, we expect these to be relatively quick updates given the more in-depth set of feedback iterations we have already gone through.

Regarding the model handover, we will provide some simple documentation; the model steps (including inputs/outputs) can be demonstrated in the handover session itself (which can be recorded as further supporting materials). Could you please advise on a timeslot that falls within any of the below that work for you?

- * Feb 22: 11:00-13:00
- * Feb 23: 09:00-13:00 or 15:30-17:00
- * Feb 24: 10:00-12:00
- * Feb 25: 09:30-11:00
- * Feb 26: 09:00-11:00 or 15:00-17:00

Regards,

[Name redacted]

[Name redacted]

Senior Consultant

elementenergy

t: [Telephone number redacted]

From: [Name redacted] <[Email address redacted]@theccc.org.uk>;
[Email address redacted]@theccc.org.uk

Sent: 27 January 2021 10:01

To: [Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;
[Name redacted] <[Email address redacted]@element-energy.co.uk>;

Subject: Timetables for finalising 6CB work.

Hi all,

Just getting in touch to check in on timings for finalising the 6CB work.

[Name redacted], I know you mentioned sending the remaining slides at the end of January. I am unfortunately still working through the first batch (I am running behind where I wanted to be on this due to a constant stream of queries and meetings on the analysis with stakeholders which is making desk time a real challenge).

Would you be happy to work on the basis of having all the work complete (the final slide pack published and the model handover completed) by the end of February? If so I think it would be good to put some slots in now for the handover sessions, and good to understand when you are planning to send over the model and instructions for use.

In terms of broader timing constraints, I still have a bulk of leave I need to use before the end of the leave year so will likely be off for 3 weeks in March. I am conscious we also need to make sure the work is completed before the end of the financial year for the purposes of invoicing.

[Name redacted]; good to know in light of this timeframe what you would propose on invoicing?

Very happy to discuss if easier.

Many thanks,

[Name redacted]

[Name redacted]

Lead analyst – Residential buildings

Climate Change Committee

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@theCCCuk<[https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=04%7C01%7C\[Email address redacted\]%40theccc.org.uk%7C86d2ae7bfa6e4392bd1108d8f05262de%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637523584861570910%7CUnknown%7CTWFpbGZsb3d8eyJWljoimC4wLjAwMDAiLCJQIjoiV2luMzliLCJBtil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=KxmcyoAgFi9KyVuOSum1PzKgJQMIaKCbW3iT6bYWMOc%3D&reserved=0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Ftwitter.com%2FtheCCCuk&data=04%7C01%7C[Email address redacted]%40theccc.org.uk%7C86d2ae7bfa6e4392bd1108d8f05262de%7C770a245002274c6290c74e38537f1102%7C1%7C0%7C637523584861570910%7CUnknown%7CTWFpbGZsb3d8eyJWljoimC4wLjAwMDAiLCJQIjoiV2luMzliLCJBtil6lk1haWwiLCJXVCi6Mn0%3D%7C1000&sdata=KxmcyoAgFi9KyVuOSum1PzKgJQMIaKCbW3iT6bYWMOc%3D&reserved=0)>