

Steering document – residential buildings modelling for the 6th carbon budget

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Assumptions

I have included below some areas where we know assumptions updates will be needed. I also intend to go through the published assumptions log to try to spot any other areas where we will need changes relative to net zero. This is on my to do list for this week or next. We should have a common aim to get all assumptions tied down over that period.

Technical potential

As discussed with [REDACTED] in email on 11/02/20

Solar thermal

Strongest evidence for cost effectiveness of various solar thermal configurations found in Solar Heat Worldwide 2018 (figure 57)¹

¹ <https://www.iea-shc.org/Data/Sites/1/publications/Solar-Heat-Worldwide-2018.pdf>

In Figure 57, specific solar thermal system costs in €/m²_{gross} are highlighted in blue boxplots for (small-scale) domestic as well as for (large-scale) commercial solar thermal applications in Denmark. The corresponding levelized cost of solar thermal generated heat (LCOH) in €-ct/kWh is shown as green bars (a green diamond equals the average value).

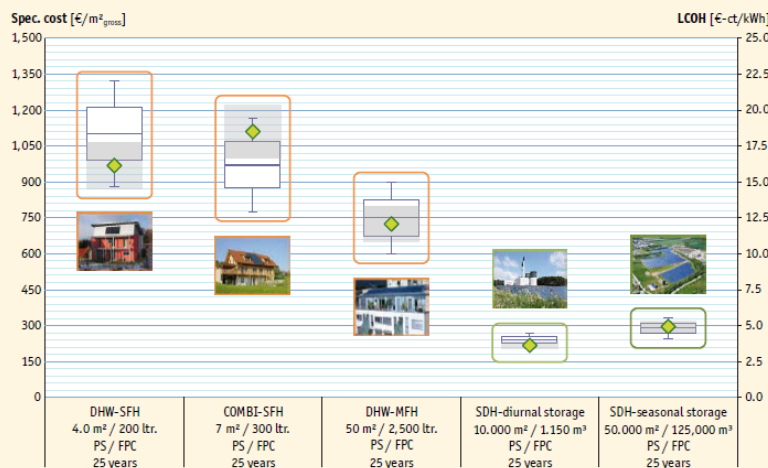


Figure 57: Specific investment costs and levelized costs of heat for different solar thermal applications in Denmark
(orange: small-scale domestic systems, green: large-scale commercial applications)

- Figure 57 shows:
 - DHW-SFH = Domestic Hot Water Systems for Single Family Houses
 - COMBI-SFH = Domestic Hot Water and Space Heating for Single Family Houses
 - SHW-MFH = Domestic Hot Water for Multi-Family Houses
 - SDH-Diurnal Storage = Solar Heat Network with the solar part designed to meet the summer peak heating load (approx. 20% of the load of the overall heat network)
 - SDH-Seasonal Storage = Solar Heat Network with the solar part designed to meet more than the summer peak heating load (typically 40 to 60 % of the load of the overall heat network)

Domestic applications

Analysis of specific solar system costs (figure 57 above) shows that at domestic level there is evidence to suggest that SH+HW systems are lower levelised costs than HW only. The potential role of solar thermal in providing space heating is supported also by discussions with an installer and by the recent update to SAP 10.1.² To reflect this evidence, **propose to include additional configuration of solar thermal in modelling.**

² https://www.bregroup.com/wp-content/uploads/2019/11/SAP-10.1-08-11-2019_1.pdf. According to [redacted] (engineer) solar for hot water and space heating is possible, even in places such as Scotland (where he works and lives) and fairly common in Scotland and outside the UK. Sense checked with [redacted]

Evidence provided by [REDACTED] suggests solar thermal can contribute to 60% of hot water demand and 50% of space heating demand with remaining gaps met by the heating system. See feasibility report of a typical system in Edinburgh ([Example Domestic with ST and Space Heating Report](#)):

Heat network applications

Analysis undertaken for Solar heat worldwide 2018 indicates that solar thermal in district heat networks represents the most cost effective application of this technology. This has been achieved in Denmark, and evidence suggests that Denmark and the UK have similar solar capacity and thus the UK is capable of benefitting from integrating solar into heat networks. Additionally, preliminary work (solar district heating trends and possibilities) suggests that the UK is one of the best countries in Europe for integrating solar with heat networks.

Evidence suggests a modest amount of solar can be integrated into heat networks (approx. 5-15%).³

- Analysis of Danish large-scale solar district heating (SDH) systems shows that economies of scale enable a huge potential for cost reduction and thus solar thermal is more cost effective in heat networks:
 - While the average LCOH for small domestic applications in Denmark ranges between 18.5 E-ct/kWh for COMBI-SFH and 12.1 E-ct/kWh for DHW-MFH
 - The average LCOH for large-scale systems (>10,000 m²) including the cost for a diurnal storage goes down to 3.6 E-ct/kWh
 - Solar Heat Network with the solar part designed to meet the summer peak heating load (approx. 20% of the load of the overall heat network)
 - For even larger systems (>50,000 m²) with seasonal storage attached a LCOH of 4.9 E-ct/kWh is achieved.
 - Solar Heat Network with the solar part designed to meet more than the summer peak heating load (typically 40 to 60 % of the load of the overall heat network)
- The low LCOH in combination with a tax on natural gas makes large-scale solar thermal a commercial business case for district heating (consumer) co-operatives all over Denmark, thus a smaller amount can be assumed for the UK.

Source:

- Evidence provided by [REDACTED]
 - Solar Heat for Cities brochure
<http://task55.iea-shc.org/Data/Sites/1/publications/TASK55--Investor-Brochure.pdf>
 - Solar Heat Networks wiki page
https://wiki.energytransitions.uk/wiki/Solar_Heat_Networks
 - Solar district Heating Trends and Possibilities publication

Commented [A1]: For the FOI request: This report has been redacted under clause 12(5)(e) of the EIR, as it contains commercially sensitive information in terms of the technical design of an optimised hybrid solar heating system. It includes information which could be used by competitors to put the company in question at a commercial disadvantage. This outweighs the public interest in sharing the information, as the specific details of the heating system shared are not key to the guidance provided to Element energy.

³ Based on the global irradiation

https://en.wikipedia.org/wiki/Solar_energy_in_the_European_Union#/media/File:SolarGIS-Solar-map-Europe-en.png, also included in the Solar Heat for Cities brochure: <http://task55.iea-shc.org/Data/Sites/1/publications/TASK55--Investor-Brochure.pdf>

<http://task52.iea-shc.org/Data/Sites/1/publications/SDH-Trends-and-Possibilities-IEA-SHC-Task52-PlanEnergi-20180619.pdf>

As discussed, our understanding is that it will not be feasible to model this but we are keen to include discussion of it at a minimum and/or give any view of how much it may be able to contribute.

Low carbon heat in heritage homes

We had 9 people respond to our survey on heat in heritage homes, with only 6 finishing it. I have worked up a very quick interpretation of the results for the purposes of adjusting the assumptions log at this stage but I would appreciate someone else looking at some point over the coming weeks to check they agree on basis of evidence.

Suitability

- Majority felt ASHPs to be suitable for some dwellings across all heritage categories (inc conservation area homes), with a couple of respondents suggesting unsuitable for all flats. *Propose retain suitability.*
- Majority felt GSHPs suitable for some dwellings across all heritage categories with no limitations for flats. Generally GSHPs got higher suitability than ASHPs for heritage homes. [REDACTED] have argued that relative to air source they have no visual impact and are noiseless. The main restrictions on suitability were around geology and availability of land to install GSHPs as well as siting of plant. *Propose increase suitability by allowing in flats and in higher % of homes than ASHPs.*
- Majority felt communal heat pump suitable for some dwellings. Generally visual barrier felt to remain as for heat pumps but with added challenge of finding suitable consolidated plant room space. *Propose aligning suitability with the above.*
- Majority felt resistive heating only suitable for some dwellings. Generally reason given is running costs. *Propose retain suitability as reason given is cost.*
- Majority felt storage heating suitable for some dwellings although higher proportion saying unsuitable in all relative to resistive heating. Reasons given include 'too expensive, ugly an uncontrollable' with the suggestion heat batteries should be used instead. Another felt it was a 'wildly inefficient and uncontrollable form of heating, irrespective of building'. Others felt it to be the same as resistive. *Propose retain suitability on basis that we cost modern efficient storage heaters, and I think we note that a heat battery + resistive is an alternative?*
- Majority felt heat networks suitable for some, with some saying suitable for all. Restrictions listed include archaeological constraints, difficulties of deploying pre-insulated pipework, and compatibility with building form. *Propose retain suitability on basis that suggested restrictions don't seem to imply significant limitations?*
- Majority felt solar thermal suitable for some dwellings, with some saying unsuitable for all. Restrictions included challenges where there is no 'hidden' roof space. No suggestion that installation generally less suitable in grade 1 than other types of dwelling. *Propose to revise to 50% suitability for all types of heritage home.*

Cost

We asked whether it was reasonable to assume that the costs for low carbon heating systems in these homes remain the same for all components except the cost of low-temperature compatible heat emitters. 4 disagreed, whilst 2 agreed.

Additional costs described include those associated with:

- Hiding air source systems externally
- Archaeological restrictions adding cost to trenching or drilling
- Extra general costs for any project associated with protecting the fabric of the site
- Additional performance issues relating to moisture movement and ventilation

When asked on the scale of the cost increase no one was able to provide detail. However, [REDACTED] has offered to provide costs via their technical team if we wish to engage with them ([REDACTED]). [REDACTED] also suggested that if we look at the ISO energy website we can find costs associated with projects.

Suggested updated suitability:

Heating systems	Heritage status			
	Conservation area	Grade I	Grade II*	Grade II
ASHP - hot water cylinder serving DHW only	50% of Detached, Semi-detached and Terraces suitable, no Flats suitable			
ASHP - small heat battery serving DHW only				
ASHP - additional thermal store to allow off-peak space heating				
GSHP (shared ground loop) - hot water cylinder serving DHW only	Can we make it a higher % of heritage buildings? No restriction on suitability for flats.			
GSHP (shared ground loop) - small heat battery serving DHW only				
GSHP (shared ground loop) - additional thermal store to allow off-peak s				
Hybrid HP - no hot water cylinder	Can we follow suitability criteria for main heat pumps?			
Hybrid HP - hot water cylinder				
Hybrid HP (off-gas) - no hot water cylinder				
Hybrid HP (off-gas) - hot water cylinder				
Hybrid HP with resistive heating				
Communal ASHP	Can we follow suitability criteria for main heat pumps?			
Electric resistive heating				
Storage heating				
Heat network				
Hydrogen boiler				
Solar thermal	50% of dwellings suitable			

Ground Source Heat Pumps



Kensa
Response.pdf

See also feedback from [REDACTED]

Water softening

Subject to your views, provisionally propose to include water softening technology as a measure to address the inefficiencies associated with lime scale build up.

- It has been estimated by the Energy Saving Trust that in areas with more than 300 mg CaCO₃/l, the costs of maintenance and water heating could be reduced by up to £50 per year by using a water softener.

Source:

- Energy Saving Trust – water softening technologies – performance standard [https://energysavingtrust.org.uk/sites/default/files/reports/Product%20Standard Water%20Softeners_Issue%201%203_FINAL.pdf](https://energysavingtrust.org.uk/sites/default/files/reports/Product%20Standard%20Water%20Softeners_Issue%201%203_FINAL.pdf)
- Domestic Heat Distribution Systems Evidence Gathering (BEIS and Element Energy) – currently a live study, but I was allowed access to the literature review.

While there are other technologies that can address lime scale build up, such as lime scale inhibitors or electrolytic scale reducers, water softener has been evidenced and related to savings.

Source:

- Domestic Heat Distribution Systems Evidence Gathering (literature review) – BEIS and Element Energy

Storage technologies

Meetings with a number of heat pump installers has suggested that there is significant potential for bill reductions associated with heat pumps as a result of smart operation with storage technologies.

I think we need to set up some bilaterals with the stakeholders who have talked about integrating storage with heat pumps to test our assumptions directly. Suggest [REDACTED] are two to include. Others were as follows:

- [REDACTED] – ‘ASHP and GSHP manufacturers need to become more aware of how they can gain value from flex. Commodity price from elec fluctuates by 200-330% every day. If for 2.5 hrs a day could avoid high cost periods, could avoid large chunk of bill.’ [REDACTED] says he has data on time shifting which he might be able to share and suggests there is data from the freedom project too.
- [REDACTED] at [REDACTED] also argued that COP is not important, it is about how and when you use the energy in terms of arbitrage around price fluctuations. ([REDACTED])

Worth also being aware that xxxxxxxxxxxx

Cost reduction assumptions

I attended [REDACTED] meeting recently on LCH technologies and the view from some manufacturers was that heat pumps are currently being built in a relatively labour intensive way (a function of low uptake in the UK, and of the variations in design required by UK specific standards) and that some cost reduction could be achieved through further automation of the manufacturing lines. The other driver of potential cost reduction was reported to be in the installation as a result of more of a ‘plug and play’ approach, reducing the number of components that need to be installed on site. Overall those present felt these developments could lead to a 50% cost reduction by 2030.

However, there are varying views and [REDACTED] had the following response:

Commented [A2]: For the FOI request: Two sentences have been redacted as they contain commercially sensitive information. They include information on a company's R&D efforts and data on their performance challenges, which could put them at a commercial disadvantage if released. This outweighs the public interest in sharing the information, as the specific details of the R&D efforts are not key to the guidance provided to Element energy.

'On the cost down piece, are you able to detail which manufacturers are making these assertions? Are they referring to the boxes themselves or to the fully installed systems? I have had comments made to me about a "reduced cost of sale" contributing to a cost reduction because manufacturers, supply chain and installers all have to work so hard in pre-sales at the moment in the UK. That said, the sort of maximum growth envisaged at the moment represents approximately 20% of European total output. Whilst extremely welcome, this is not that significant so, in itself, is unlikely to see the costs of devices halving. Heat pumps are not, to the best of my knowledge, selling for significantly less in Continental Europe. If you can provide a bit more detail around the question, I will try to comment further and to get some installer input if that would be welcomed'.

Suggest testing further both through bilateral testing (is the best approach for me to email some of the contacts from the WEF?) and at the workshops.

Measures to include

Discussions in progress on this, current view set out below (although this is something I anticipate will continue to evolve).

Energy efficiency

See assumptions shared by [REDACTED] and my email to [REDACTED] on 12/02/20 which had some initial thoughts on measures and packages:



1 - Final Savings



2 - Final Savings



3 - Heritage



5 - Final Costs



4 - CCC 6B Data

07022020 Option A 07022020 Option B - Suitability 3101202007022020_F - review Note 4.0 - personal

Important things to note when applying: [REDACTED] costs need to be converted to the correct price year. [REDACTED] kWh savings are savings at the meter in gas heated homes. To get the % they are compared against the total gas consumption baseline from NEED. Given the kWh savings are savings at the meter for gas heated homes, we need to be careful in making the appropriate conversions to identify savings at the meter in electrically heated homes for the different heating systems.

One point that also came up in a discussion with [REDACTED] recently on assumptions is the fact that the energy savings in her assumptions relate to gas, not to secondary heating systems. I'd be grateful if someone could think about the treatment of secondary heating systems in the modelling in this context. I think there is something on it in the NEED methodology note and I am keen to understand whether we generally overestimate consumption from these systems if we are not accounting for savings in the energy efficiency assumptions.

Low carbon heat

- District heat (there is a question about how we disaggregate this in reporting, see [here](#) for how it was done for 5CB)
- Electric storage
- Electric resistive
- ASHP
 - Standard ASHP
 - With small heat battery for DHW
 - With additional thermal storage for SH
- GHSP

Commented [A3]: For the FOI request: NB– this is very out of date

- Standard GSHP
- With small heat battery for DHW
- With additional thermal storage for SH
- Hybrid heat pumps (ASHP + gas/h2/biomass boiler)
 - On gas grid
 - Off gas grid
 - Without storage for DHW
 - With storage for DHW
 - With resistive heating
- Hybrid heat pumps (GSHP + gas/h2/biomass boiler) anticipated to be necessary following discussions with [REDACTED]
 - On gas grid
 - Off gas grid
 - Without storage for DHW
 - With storage for DHW
 - With resistive heating
- Solar thermal
 - Modelled as per input from [REDACTED]
- Communal ASHP
- Communal GSHP anticipated to be necessary following discussions with [REDACTED]
- Hydrogen boiler
- Biomass boiler

Other

- Heating controls
- Thermostat
- Water softening tech?

More generally we have talked about needing to be able to model a behaviour-led scenario, which will include more ambitious assumptions e.g. on thermostat temperatures, energy efficiency uptake etc. and that there is value in considering what other measures could be included here. Worth being aware that our central team are doing some work with [REDACTED] to look at two low energy demand scenarios across the economy (informally these can be described as 'ultra low' and ultra ultra low' demand). The intention is to use their primary output (economy-wide demand, split by sector) as a comparator to our CB6 energy demand scenarios. In addition the input assumptions are likely to be useful for us in scenario development/sensitivity analysis, I suspect particularly for the behaviour-led scenario. See below for the LED template which includes a description of some of the assumptions they will be working up (see shelter and services tabs) and on the instructions they are working from.



6 - LED Template - 7 - Instructions for names redacted.xlsx
LED Scenario - name

I imagine we could make use of a range of these assumptions for our behaviour led scenario including the indoor temperature requirement, thermal improvement, time used and temperature required for water heating etc. Worth thinking now about how they might be worked in

Commented [A4]: I believe we modelled this for net zero as bio LPG, is this the best approach to retain?

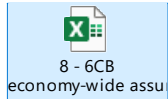
Commented [A5]: for SCB we had 'full', 'timer +TRV', 'TRV only' and 'cylinder thermostat' – what is it feasible to include this time round?

Commented [A6]: Modelled for SCB as 1 degree C decrease, when looking at the 2013 Element report underpinning it, this seems to be represented as a target internal temperature of 17 rather than 18 degrees. I think there is value in thinking more carefully about how we model this as I have never fully understood the SCB representation. Worth discussing with [REDACTED] and also speaking to [REDACTED] who is looking at this too and coming up with some assumptions for a low demand scenario (see below).

Commented [A7R6]: Also see emails search = 19C recommendation to see the discussions we had around this last year.

Central modelling assumptions

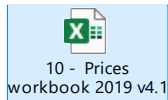
Our central team have now shared a range of central modelling assumptions, please see attached.



Commented [A8]: For the FOI request: NB– this is very out of date

Energy prices

Please find the energy prices workbook here:



Commented [A9]: For the FOI request: NB– this is very out of date

Please note an updated version will need to be sent at some point. This will include assumptions we have developed on BioLPG for costs, emissions intensity and also a supply constraint. Will also be able to provide information for conversion between final and primary for the purposes of reporting.

I am going to work up an additional tab which gives a view on the prices I think we should be using for different scenarios (i.e. cost components added and removed to make them up).

You will see that we have a more disaggregated list for heat prices than we did for net zero. The ambition with this list was to allow for a better representation of different forms of flexibility in the modelling. The prices are designed so that e.g. space heat for a particular home will be 100% allocated to one of the pricing categories (i.e. we wouldn't allocate 50% of demand in a home to be flexible and 50% inflexible). We have:

- Electricity residential: To be used for all non-heat uses
- Space heating
 - o Flexible: This is intended to be used where homes are capable of pre-heating.
 - o Inflexible: Intended to be used for homes which are not capable of preheating.
 - o Storage: Intended to be used for homes which have technologies allowing them to be highly flexible in matching demand to low-price periods, e.g. storage or hybrid heat pumps. The idea is that they can achieve lower bills than those homes which can simply pre-heat.
- Hot water
 - o With storage: Intended to be used where hot water can be stored and so can benefit from some flexibility/lower prices.
 - o Without storage: Intended to be used where hot water cannot be stored and so is less flexible.

To more thoroughly explain the rationale behind these prices, I have been in quite a few discussions with heat pump providers who have argued that the scope for bringing running costs down in the future does not lie with improved SPFs but instead with smart usage to take advantage of the lowest prices. I was keen we had the ability to incorporate this and improve our representation of flexibility in the work and we decided that to do so we needed to be able to cost flexibility in space heat and hot water separately (because e.g. thermal storage in fabric of home does nothing for hot water) and that there is value in differentiating between the benefits of pre-heating and truly dynamic use.

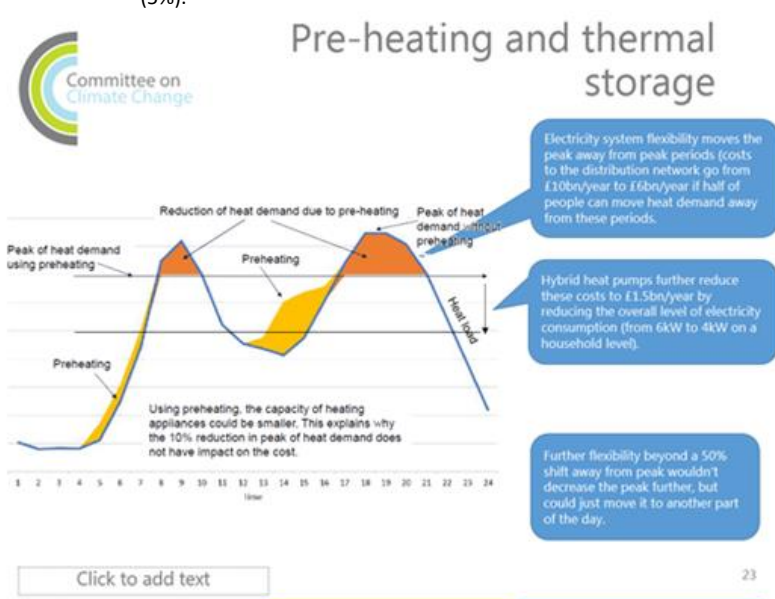
The prices were modelled on the following basis (still seeking some more detail):

- Space heating

- **Flexibility:** we assume that flexible technologies can pre-heat up to 4 hours outside of peak hours. This reflects the impact on transmission and distribution costs estimated by Element for the Accelerated Electrification work - specifically, this is based on the Rapid HHP scenario. In addition, electricity prices reflect higher levels of gas-fired generation (15%) than our baseline electricity costs (5%). [REDACTED] had pulled out the chart below that summarises what we mean by pre-heating.
- **Inflexible:** in this case, we assume that end-users cannot move away from peak time and thus pay higher electricity prices on average. Differently said, inflexible prices are a blended price that reflect the costs of paying peak prices 40% of the time and baseline prices 60% of the time.
- **Storage:** homes with storage are assumed to be fully flexible, meaning that demand can be moved to match the moment when renewables are generating (and prices are lower).

- Hot water

- **Without storage:** in this case, we assume that end-users cannot move away from peak time and thus pay higher electricity prices on average. We assume that end-users thus pay peak prices 80% of the time and baseline prices 20% of the time. The LRVC reflects a blend of these two prices.
- **With storage:** we assume that the consumption of hot water occurs up to 4 hours outside of peak hours. The prices then reflect the impact on transmission and distribution costs estimated by Element for the Accelerated Electrification work - specifically, this is based on the Rapid HHP scenario. In addition, electricity prices reflect higher levels of gas-fired generation (15%) than our baseline electricity costs (5%).



Flexibility

In generating our prices, we have assumed some flexibility, which needs to be reflected in the way we design the modelling.

We wish to include pre-heating as a key source of flexibility. Work [REDACTED] has done for [REDACTED] in the past has suggested that there is actually quite a lot of potential for preheating in homes. [REDACTED] analysis assumes 100% of the heating demand for new houses to be flexible and available for pre-heating, and 50% of post-1952 buildings to flexible and able to shift their heating demands via preheating or thermal storage for up to 4 hours away from peak periods. This 50% figure is a reflection of the assumption that all post-1952 homes CAN preheat, but only half of them do. The prices assume that 25% of post 1952 homes in 2025 preheat and 50% in 2030.

There are two angles to representing it in the modelling. One is that we need to be able to identify post 1952 homes in the archetypes to identify which are allocated the flexible pricing. The other is that clearly it isn't only post-1952 homes that have the technical capability to pre-heat, it will also be pre-1952 homes that have had their energy efficiency upgraded to post-1952 levels. Slide 13 in the below slide pack has assumed space heat demand levels with the different categories of homes, and hopefully could be used to find a way to represent this.

It will be valuable for us to run our representation by [REDACTED] once developed in order to sense check. It may be in that in the behaviour-led scenario one thing we wish to do is to increase our assumptions on the number of homes which take up pre-heating (i.e. assume more than 50% of those that technically can)



Commented [A10]: For the FOI request: NB– this has some out of date figures

To give you a sense of how I understand the range of prices would play out:

	Space heat - Flexible	Space heat - Non-flexible	Space heat - With storage	Hot water – with storage	Hot water – without storage
Air source heat pumps in homes which can preheat	100%				
Air source heat pumps in homes which cannot pre-heat		100%			
Ground source heat pumps in homes which can preheat	100%				
Ground source heat pumps in homes which cannot preheat		100%			
Resistive heating in homes which can pre-heat	100%				
Resistive heating in homes which cannot pre-heat		100%			
Storage heating			100%		
Heat pumps plus thermal or heat battery storage (i.e. additional)					

Commented [A11]: Applied where you have a hot water tank or heat battery

Commented [A12R11]: Not sure if relevant but SAP 10.1 mentions: The procedure does not allow for the case where a solar thermal system providing water heating and a Storage WWHRS are both present.

Commented [A13]: Applied where you have point of use

hot water cylinder or heat battery)					
Hybrid heat pumps			100% of elec demand		

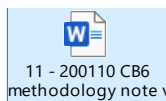
Commented [A14]: Question about how we treat these?

Policy representation

Initial discussions and thinking already discussed. Awaiting next level of detail in terms of proposals for implementing, including EPC approach.

Modelling approach for emissions and costs

Please read the following methodology note for guidance, I have included some early thoughts on some of the steers but will need to evolve thinking further:



Commented [A15]: For the FOI request: NB– this is very out of date and not the latest version which CCC use

This is an internal CCC document so not for wider sharing.

Scenario thinking

Baseline

Discussions with BEIS ongoing to get a correctly calibrated baseline. After correlating with NEED, is the intention this time round to calibrate to national energy consumption or emissions? If the former we at least need to do a check that our numbers are in line with the latest final emissions inventory for residential combustion.

Alternative and central scenarios

Latest thinking as presented to steering group:



Max

[To be added]

Sensitivity list

[To be added]

Cobenefits

For net zero we included an additional 3.25 million additional solid wall measures in the model, achieved through the application of 3.25 million additional medium packages in suitable, solid wall archetypes.

We will want to think more carefully about fuel poverty and other co-benefits in our scenario design. There is also a question about whether there is scope to better quantify any other cobenefits. Good to discuss.

Reporting

Please find the final reporting template attached.



13 - CB6 scenario
template - Master v4

Commented [A16]: For the FOI request: NB— this is out of date and not the latest version which CCC use

Things which have changed since the last version include:

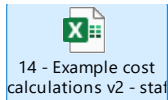
- Rows added in Scotland, Wales and NI sheets to allow changes in energy demand, costs and investment to vary by DA
- Wider list of co-benefits added
- An abatement method hierarchy has been added at the end of the measures tab. The hierarchy is broadly:
 - Demand reduction
 - Energy efficiency
 - High-efficiency electrification
 - Lower-efficiency electrification/H2/CCS
 - Sequestration

The aim of this section of the spreadsheet is to log the proportion of abatement associated with each action, in order to enable us to present an aggregate view at the end. Turning down the thermostat for instance would be 100% 'do it less'. Generally this is a hierarchy we are using to think about how to build scenarios (and balance of effort) as well as a guide for reporting (we should be applying and reporting on measures in the order below, i.e. the first rows should be savings from demand reduction, then rows representing energy efficiency measures, then rows associated with heating systems etc).

- An energy efficiency sheet has been added. At report stage we wish to give an indication of the savings in our scenarios which result from improved energy efficiency specifically. We need to think about how we might represent this and there are a couple of potential options in the template. For net zero we had the % energy demand reduction associated with energy efficiency so we could take this approach again, although ideally we want to also represent the share from improved efficiency of heating systems.

I will need to go through and add comments to illustrate the approach I am envisaging for filling it out. Some things to be aware of:

- There is a limit on 1000 rows – we'll need to think about how granularly we wish to disaggregate the measures. I will include some thoughts on this when I add comments to the attached in the next iteration.
- There is provision included both for "new unit" abatement cost (£/tCO₂e) and average measure abatement costs as described in the modelling approach doc. We now also have an example of the two different £/t calculations we will need to report on, developed by the central team. I have attached this below



- At a minimum the total sector baseline for UK and DAs is required but we can also provide a disaggregation of the baseline by sub-category if useful (it likely will be given we are publishing a version of the spreadsheet). Not sure if you have views on how it would best be disaggregated (it needn't be linked one to one to mitigation measures).
- Note the tab for the investment baseline which is new relative to net zero
- There are drop down lists for measures to identify whether they are reserved or devolved and also to add in co-benefits.

Questions:

- Do you see any problems with items included in the template?
- Are you able to calculate an energy baseline and investment baseline for Scotland, Wales and NI?

As discussed, the attached will be the formal reporting template – we may still want a second more detailed template output to be generated to support internal analysis around the scenarios.

Commented [A17]: For the FOI request: NB– this is out of date and not the latest version which CCC use