Common Evaluation Methodology (CEM)

Cost Benefit Analysis User Guide (Version: 2.0)

Contents

1   Introduction

This document is a User Guide for the Common Evaluation Methodology (CEM) Cost Benefit Analysis (CBA) tool, and should be read in conjunction with version 2 of that tool (**CEM Tool v2.0**).

The primary purpose of the tool is to allow the user to assess the merits of deferring reinforcement (or similar capex solutions) by employing flexibility solutions (e.g. Demand Side Response) for one or more years, although it can be used for evaluating a range of intervention options. The model allows the user to test different flexibility strategies under different load growth scenarios. It also provides insights that should help the user to make strategic decisions when uncertain about which network load growth scenarios will outturn. This document provides guidance on how to populate and interpret each tab within the model, as described in each of the sub-sections below.

2 Step-by-step overview

This section of the user guide provides a high level overview of how a user might go through the process of populating the CEM tool.

Table 1   Overview of how to populate the CEM tool

Step #	Description
1	**Fixed Inputs tab:** Check that all values are up to date.
2	**Control tab:** Select the scenarios and strategies to be modelled, the reference and start years, and the method for inputting exceedance and flexibility costs.
3	**Control tab:** click the *"Update Configurations"* button.
4	**Inputs tabs:** Input all relevant parameters for the selected scenarios and strategies, noting any sources or assumptions in the "Workings" tab.
5	**Additional inputs and control:** Select the scenario to be used as the Best View, and define any limits on the amount of flexibility available, the minimum contract term for flexibility services and any discount for longer contracts.
6	**Run model** by clicking '*Calculate Benefit*' button and '*Calculate Ceiling Price*' button (changing parameters ceiling price search parameters if required)
7	**Benefit by strategy, Insights and Reporting**, **Ceiling Price** and **Option value** tabs: Review results.

3 Guidance by worksheet tab

Intro tab: Guidance

Intro

- ► **Purpose of CBA:** Describes the aim of the investment decision

Inputs

- ► **Control:** Defines modelling parameters and run analysis.

- ► **Baseline Reinforcement:** Reinforcement costs and site capacity (current, projections by scenario). The Baseline strategy is the reinforcement option in this tool.

- ► Flex cost inputs (2 variants depending on Control settings):
  - a. **Flex Cost Inputs:** Flexibility cost estimates are input directly.
  - b. **Flex Volume and Cost Inputs:** Flexibility volume requirements and price assumptions are input.

- ► **Flex Costs Summary:** Summary flexibility cost data given selected inputs, including option to add in multi-year flexibility procurement discounts.

- ► **Incentives, Penalties & Societal Impacts:** Impacts related to incentives and penalties for each scenario i.e. losses, CIs, CMLs.

- ► **Fixed Inputs:** Financial assumptions and prices applicable to your business.

- ► **Embedded emissions inputs:** GHG emissions per asset installed in the baseline reinforcement option.

- ► **Carbon impacts:** GHG emissions associated with changes in losses, embedded carbon, the flexibility service procured and other sources defined by the user.

- ► **Workings:** (Optional input) Calculations used to derive flexibility requirements and/or incentive-related impacts.

- ► **Additional inputs and control:** Additional inputs on Best View, maximum flex availability, contract lengths and flexibility service cost discounts.

Analysis and Insights

- ► **Benefit by strategy:** CBA results showing the Net Present Value (NPV) by scenario, strategy and deferral duration.

- ► **Insights and Reporting:** Insights on optimal deferral years and maximum flexibility value for specific strategies and scenarios, and across scenarios on a Least Worst Regret and Weighted Average basis.

- ► **Ceiling price:** Calculates the availability ceiling price (or indifference price) above which flexibility of any duration is sub-optimal.

- ► **Option value:** Presents results with and without the consideration of uncertainty in load growth scenarios.

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Background calculations

► **Comparison, Baseline & Scn1-10:** Tabs with no user input required. The NPV of each option (Baseline, and up to ten combinations of scenarios and strategies) is calculated, following the standard Ofgem CBA methodology. The NPV results are linked through and presented in the Analysis and Insights tabs.

Intro tab: Purpose of CBA

The user documents the network need, and the options that the CBA is being used to evaluate. This has no impact on any calculations in the model, but allows a future user to understand the intent of the particular model setup.

Inputs tab: Control

In this sheet, the user sets the parameters for the modelling run, including the model start year and the Reference year. All prices in the model should be input in real terms aligned to this Reference year. NPVs are calculated by discounting future costs and benefits back to the Reference year.

The user chooses whether to input the baseline exceedance directly or to derive it from network load and rated capacity. This choice will hide redundant rows in the **Baseline Reinforcement** tab.

The user chooses whether to input flexibility cost assumptions directly, or to input flexibility volume and price assumptions in order to derive flexibility costs. Each input method has its own input sheet, so this choice will hide the sheet not used. Also, by inputting flexibility costs directly, the **Ceiling Price** and **Option value** logic is non-functional, so these tabs becomes hidden if this option is selected.

The user then chooses a list of scenarios and strategies, up to a total of 10 "configurations". We define these as follows:

- ► **Scenario:** A scenario that defines the load growth for the network, e.g. "Steady Progression"

- ► **Strategy:** What the DNO will do to mitigate the exceedance that arises from the scenario, e.g. "Flexibility"

- ► **Configuration:** The combination of strategy and scenario that will be tested by the model, e.g. Flexibility under Steady Progression

The user can input a long list of scenarios and strategies, then select from this list using the drop-down. Configurations must be listed from Config1 down (i.e. you can populate Config1-4 then leave the rest blank, but do not populate only Configs 1, 3, 5 and 7).

For each configuration, the model specifies the last year at which a strategy can be effective. This is based on the volume of flexibility (in MVA) required to accommodate the load growth, and the maximum flex availability specified by the user on the **Additional inputs and control** tab.

Once the parameters are chosen, in order to set up the model correctly the user must click:
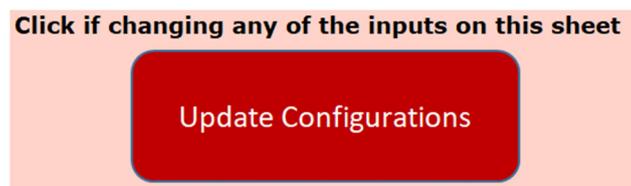
This will hide redundant sheets and rows as per the descriptions above.

Inputs tab: Baseline Reinforcement

This tab holds the exceedance of the network under each scenario, and the Baseline reinforcement expenditure profile. Depending on the parameter chosen in the **Control** tab, the user can either input the exceedance profile directly for each scenario, or can input the network load growth and the assumed network capacity.

The important outputs of this tab are the baseline expenditure profile and the intervention start year, which is the first year that exceedance occurs in the selected control scenario.

In cell *D4* the user can choose one of two ways to determine at which year an intervention is first required:

1. **Manual input:** The user states in which year some form of intervention is needed, in which case the model will use the value chosen in cell *D5*
2. **Determined by scenario:** The user chooses a load growth scenario (in cell *D6*), which the model then uses to calculate the first year in which an intervention is required.

The subsequent years of exceedance should correspond to the flexibility requirements in the **Flex Costs Summary** tab.

Inputs tab: Flex input a) Flex Costs Inputs

Note: Sheet only visible and used if flex_cost_input_type (in Control sheet) is set to "Input all flex costs directly"

The user specifies their projection of the costs associated with flexibility procurement. Where there are upfront or fixed costs that could be shared between schemes (e.g. central dispatch control), it is up to the user to decide how to apportion those costs to the particular scheme being tested in the CBA. As a general rule, when deciding whether to use flexibility in this particular scheme, costs that have already been incurred (e.g. central dispatch control systems) should not be included in this CBA since they are 'sunk' and cannot be avoided by choosing not to do flexibility in this particular instance.

Upfront costs are incurred regardless of how long the flexibility strategy is pursued. However, the other costs (annual fixed costs, availability costs and utilisation costs) are only incurred if the flexibility strategy is active. *For example, even if availability costs are specified over a 10-year horizon, if the model is considering the value of a 2-year baseline deferral, it will only consider 2 years of availability costs.* Therefore, the user can populate the model with a full horizon of cost projections, then use the model to test the Net Present Value (NPV) of different deferral periods.

Inputs tab: Flex input b) Flex Volume and Cost Inputs

Note: Sheet only visible and used if flex_cost_input_type (in Control sheet) is set to "Flex Costs from Volumes"

The user sets the initial price assumed for availability and utilisation, along with a trajectory for availability prices over time to account for possible price trends in the market. The user then specifies, for each configuration:

▶ **Upfront fixed costs:** These are incurred regardless of how long a flexibility strategy is in place (i.e. even if reinforcement is only deferred by 1 or 2 years)

▶ **Annual fixed costs:** These costs are only incurred whilst the flexibility strategy is in place (i.e. if reinforcement is only deferred for 2 years, these costs will only be incurred for 2 years, even if there are costs in this input from year 3 onwards)

▶ **Availability volumes:** In order to calculate the annual availability cost, the user specifies the capacity (MVA) of availability response required, and the number of hours per day and days per year it will be contracted. In reality, procurement may be more complicated (including for example different volumes for different months, and arming fees) so this model is a necessary simplification. What matters though is that the total cost of procured flexibility represents the expected cost of a DNO's particular contracting approach.

▶ **Utilisation volumes:** The user specifies the expected annual utilisation dispatch volume.

Inputs tab: Flex Costs Summary

Summarises the flexibility costs based on the user inputs, either from the Flex Cost Inputs tab or the Flex Volume and Cost Inputs tab, depending on the chosen state of the *flex_cost_input_type* parameter in the Control sheet.

Inputs tab: Fixed Inputs

This tab contains all fixed parameters as per the Ofgem CBA template. The values are consistent with the CBA template published by Ofgem for RIIO ED2 (version 9) and should be updated accordingly for future changes in the template. The inputs include:

▶ Capitalisation rates

▶ Pre-tax WACC

▶ Discount Rate <= 30 years

▶ Discount Rate > 30 years

▶ Discount rate for safety <= 30 years

▶ Discount rate for safety > 30 years

▶ Marginal grid carbon intensity (tCO_2e/MWh)

▶ Assumed Asset Life (Years)

▶ Cost per Fatality (£m)

▶ Cost per Non Fatal injury (£m)

▶ Cost per litre oil (£/litre)

▶ CI (£s per interruption)

▶ CML (£s per minute lost)

▶ Carbon price ($£/tCO_2$)

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The user should enter the Pre-tax WACC and CI and CML costs as per their business plan. The CPIH Index can be used to help the user convert all costs and benefits to the tool price base. The tool price base is currently set at 2020/21 prices.

Inputs tab: Incentives, Penalties and Societal Impacts

The user can populate this tab with other benefits or adverse impacts associated with either the Baseline or one of the selected strategies. This includes losses, Customer Interruptions (CIs), Customer Minutes Lost (CMLs), and other environmental and safety metrics.

Strictly, this should only include metrics against which a DNO is incentivised, with the cost or benefit relating to the appropriate rate set in the Final Determinations. However, the tool does have functionality to consider other societal benefits such as CO_2 emissions (see below). If populated, these wider societal benefits will be included in the overall NPV of a strategy, even if the cost or benefit does not strictly accrue to the DNO (i.e. these may be customer or wider societal benefits).

The unit cost or value associated with these is set in the **Fixed Inputs** tab. The purpose of this tab is to allow the user to reflect that a strategy may have different outcomes compared to the Baseline (e.g. using flex may incur higher or lower losses than conventional reinforcement). So whilst non-zero values can be entered into the Baseline, the model only considers the delta between the Baseline and each strategy. For this reason, it may be clearer to leave the Baseline values in the Incentives, Penalties and Societal Impacts tab as zero, and assess all strategies relative to this Baseline.

As with the flexibility costs (excluding upfront costs), any incentives or penalties will only be taken into account whilst the flexibility strategy is being enacted, even if the user inputs costs and benefits over a longer horizon. For example, if flexibility is used for 2 years, the net societal costs and benefits from years 3 onwards will be zero.

Inputs tab: Embedded Emissions Inputs

This tab calculates the embedded GHG emissions (tCO_2e) in the baseline reinforcement option. It allows the user to insert information on the number of assets installed and the embedded GHG emissions in each asset. The tab is populated with preliminary estimates of the embedded carbon which the user should review and update accordingly.

Inputs tab: Carbon Impacts

This tab collates and calculates the GHG emissions (tCO_2e) associated with each configuration and the monetary value of changes in emissions based on the carbon prices specified in the **Fixed Inputs** tab.

The tab is separated into four areas:

- ▶ Emissions associated with losses
- ▶ Embedded emissions in the reinforcement option
- ▶ Emissions associated with the energy used to meet capacity requirement (i.e. the flex option)
- ▶ Other emissions impacts

The emissions associated with losses and the embedded emissions in the reinforcement option are calculated automatically based on the inputs provided by the user in the **Incentives, Penalties and Societal Impacts** tab and **Embedded Emissions Inputs** tab.

The emissions associated with the energy used to release additional capacity at the site captures the emissions intensity of the energy used for the flexibility solution relative to the baseline reinforcement option. The user should enter the emissions factor of each option over time, factoring in changes in the generation mix and efficiency of solutions where appropriate. The table below provides examples for the potential source for these assumptions based on the type of intervention in each option.

Type of intervention	Source of energy to meet capacity requirement	Relevant emissions factor
Reinforcement	Electricity from the grid	Marginal electricity GHG conversion factor in Fixed Inputs tab
Diesel, gas or other fuel generators	Diesel, gas or other fuel	Emissions factors from Defra guidance on GHG reporting
Battery storage with renewables as the source	Electricity from renewables	Zero
Energy efficiency	Demand reduction	Zero
Demand side response	Electricity from the grid	Depends on where load is being shifted from and to in the day (i.e. peak or off peak)

The model combines the difference in emissions factors with the utilisation data to calculate the change in emissions associated with the energy used to meet the capacity requirement.

All other differences in emissions can be recorded in the other emissions impacts section.

Inputs tab: Workings

This tab allows the user to insert background workings to some of the manual entry inputs in the "Flexibility Requirements" and "Societal Impacts" tabs (or other inputs) as appropriate. Note, this tab has no effect on the calculations within the model.

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Inputs tab: Additional Inputs and Control

This tab allows to set additional constraints and inputs that influence the calculations in the model. This includes:

- **Scenario for intrinsic value calculation:** In order to calculate the 'intrinsic value' of flexibility (i.e. its value when there is no load growth uncertainty) the user needs to specify which scenario is acting as the 'Best view'. This influences the representation of option value on the **Option value** tab

- The **maximum amount of flexibility available** across all scenarios in MVA (i.e. the maximum volume of flexibility (in MVA) that the user believes can be procured to address the constraint

- The **minimum initial contract length** in years that the user wishes to procure (setting this to 1 will imply a rolling 1 year contract throughout the modelling horizon, whereas choosing a higher number will mean the initial flexibility contract will be longer)

- The discount to be applied to flexibility prices for multi-year contracts

- The Contract length (years) to test within the tool (these do not need to be consecutive, but must be in ascending order e.g. 1,2,3,4,5,6,7,8,9,10,15,20,45)

- The probability assigned to each scenario (used for the Weighted Average approach represented on the **Insights and Reporting** and **Option value** tabs.

This tab also allows the user to run the model. In order to calculate the benefit at the specified flexibility input price, the user clicks:

Calculate Benefit	Click to calculate benefit @ specified flex price

In order to calculate the ceiling price, the user first specifies the search parameters (goal seek increment and maximum availability price) then clicks:

Calculate
Ceiling Price
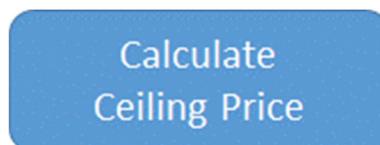
Note: Unless these buttons are clicked, the Analysis and Insights tabs will not update and will not correspond to the input values.

Analysis and Insights tab: Benefit by strategy

This is the first output tab, and shows the benefit of each strategy under each scenario. These representations are also shown graphically within the tool in four charts:

- ► **Optimal reinforcement deferral duration by strategy and scenario:** Shows the length of deferral that gives the highest NPV

- ► **NPV of optimal reinforcement deferral by strategy by scenario:** Shows the NPV of the optimal deferral length, i.e. the maximum NPV that can be achieved

- ► **Cumulative NPV of deferring by a number of years vs the baseline strategy:** Shows the NPV of deferring the baseline expenditure by a certain number of years, i.e. the cumulative benefit of each year of deferral to the specified duration (e.g. "Defer by 3 years to 2027")

- ► **Marginal NPV of deferring from one period to the next:** Shows the benefit of deferring by an additional year (or, where the modelled years are non-consecutive, from one snapshot to the next) i.e. the marginal benefit (e.g. "Defer from 2026 to 2027").

Detailed results tables are given below the charts. In order to understand what is described in each of these tables, it is important to remember the two separate questions that this tool is addressing:

1. **Total strategy duration and value:** For a given strategy (e.g. flexibility) under a given scenario (e.g. Steady Progression), for how long does it make sense to defer the Baseline (reinforcement) costs, and what is the value of doing so?

2. **Initial contract duration and value:** For a given strategy and scenario, how long should the initial flexibility contract (or similar) be, and what is the value of deferring the baseline costs for that period?

The model recognises that even if it makes sense, knowing what we know today, to defer reinforcement for, say, 4 years, the DNO does not necessarily need to sign up to a 4-year flexibility contract on day 1. It can instead secure, say, an initial 3-year flexibility contract, then procure an additional year of flexibility once that initial contract expires, if the CBA for doing so is still positive at this stage. Where a minimum contract length is specified, the model automatically adjusts the results to show the NPVs for the contract duration, and for each additional year thereafter.

The tables in this tab show three sets of results:

1. **Benefit of initial deferral (cumulative and marginal):** These show the NPV of deferring the Baseline (reinforcement) costs by n years (where n is the number of years in the header row), taking account of any discount associated with multi-year contracts. Data appear from the final year of the minimum contract length, where specified. Note that these results are shown both on a cumulative and a marginal basis. For the cumulative view, the optimal number of deferral years should correspond to the maximum NPV, which will be highlighted in green. Although subsequent deferral years may still show a net positive NPV overall, the fact that the cumulative NPV is below this optimal level means that value is being eroded. This will be reflected in the Marginal benefit table.

2. **Residual benefit after initial deferral:** This shows the additional NPV that can still be secured by signing additional flexibility contracts after the initial n-year contract. The model assumes that no multi-year discounts apply to these subsequent contracts.

3. **Overall benefit:** Shows the total NPV (initial + subsequent) associated with flexibility contract(s) of n years' duration. The optimal deferral length (or deferral lengths) is highlighted in green. Note that the model may show a number of years with the same optimal NPV outcome. This will be because the cost of rolling 1-year flexibility contracts has the same cost as procuring the full optimal deferral length in one go.

Analysis and Insights tab: Insights and Reporting

This tab summarises the results from the **Benefit by strategy** tab. It also provides additional analysis to identify which strategy would be optimal, and over how many years, given the uncertainty associated with having multiple possible future scenarios.

This first section simply summarises the **Benefit by strategy** findings. It shows for how many years Baseline (reinforcement) deferral has a positive NPV, and what that NPV is. It also breaks this NPV into the initial value (associated with the initial flexibility contract) and the subsequent value (any further deferral that can be achieved after the initial contract has expired).

Up to this point, each scenario and strategy has been treated individually. However, the DNO needs to make a decision regarding the procurement of flexibility (or some other strategy) without knowing which scenario will outturn. This tab provides two methods for making this assessment:

▶ **Analysis: Least Worst Regret method** - This section presents the results of a Least Worst Regret approach.[1] In the case of flexibility, this analysis reveals the initial flexibility contract length that gives you the "least worst" regret across all the modelled scenarios. This is typically a short contract length, since this allows you to lock in the benefit under most or all scenarios, whilst avoiding procuring flexibility in those scenario years where the NPV may subsequently go negative (i.e. where the cost of flexibility is higher than the benefit of deferral and associated incentive-related benefits).

▶ **Analysis: Weighted Average method** – This section allows the user to apply probabilities to each scenario, then to calculate the weighted average NPV by strategy. This tells the user what NPV they should expect to secure by procuring, say, a flexibility contract of n years. The analysis then identifies the optimal value for n (i.e. how long the contract should be) and what the expected NPV would be (again noting that even if the contract is short, there is still subsequent value that is taken into account).

Analysis and Insights tab: Ceiling Price

Note: This tab is only usable if flex_cost_input_type (on the Control sheet) is set to "Flex Costs from Volumes", i.e. the user calculates the cost of flexibility on the basis of explicit flexibility volumes and flexibility prices.

This tab calculates the availability price at which the user should be indifferent to a Baseline or a flexibility-type strategy. Below that price, flexibility has a positive NPV for at least the minimum flexibility contract length, whereas above that price the NPV of flexibility will be negative.

The user has to specify all parameters other than the initial availability price (***Avail_price*** on the **Flex Volume and Cost Inputs** tab), including the utilisation price, the availability price trend, availability

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[1] Regret is defined as the maximum benefit that you could have achieved under a given scenario minus the benefit that you actually achieved.

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and utilisation volumes, fixed costs, any incentives or penalties, and any assumed discount associated with multi-year flexibility contracts.

The model will search in the specified increments from a zero availability price up to the maximum availability price.

The tab reports, for each strategy under each scenario, the availability ceiling price, i.e. the price above which the strategy does not give a positive NPV for any flexibility contract length. It also shows the maximum average annual cost (including fixed, availability and utilisation fees) above which flexibility is not justified.

This tab also shows the ceiling price for the initial contract when applying the Least Worst Regret and Weighted Average valuation methodology. As well as the ceiling availability price, it shows the ceiling flexibility cost, although it should be noted that the tool uses the flexibility volume associated with the 'best view' scenario in order to make this calculation.

Analysis and Insights tab: Option Value

This tab separates the results from the **Benefit by strategy** tab and **Insights and Reporting** tab into the intrinsic value and extrinsic value under each strategy.

The *intrinsic value* shows the value of deferring reinforcement in the absence of any uncertainty (i.e. under the 'Best View' scenario). The *extrinsic value* or *uncertainty benefit* captures the additional value provided by flexibility given the uncertainty associated with having multiple possible future scenarios. This uncertainty benefit is calculated using a weighted average of the probability of each scenario specified by the user in the **Additional Inputs and Control** tab.

Background calculations: Comparison, Baseline and Config

These are calculation tabs and should not be changed by the user.

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4 Use Cases

This section describes some of the different ways in which the CEM CBA tool can be used. This includes the primary use case (the deferral of conventional reinforcement through the procurement of flexibility services). It also includes variants that can be examined, including an ANM use case and an energy efficiency use case.

Use Case 1: Flexibility for reinforcement deferral

The guidance in the previous section is written with the primary use case in mind: the user specifies the costs associated with a flexibility contract, and compares it to the benefit of reinforcement deferral, along with any associated incentive-related costs or benefits.

It is worth noting that 'flexibility' can take different forms. The language of the model describes availability payments and utilisation volumes, which relate to flexibility service agreements. However, if the user wants to investigate the use of, say, purchasing flexibility as a service from a temporary battery or generator they can use the same input fields to specify perhaps the 'annual service fee' and the 'annual usage cost'.

What is important for the model is that the annual cost of flexibility is calculated, and then compared with the value of reinforcement deferral and associated incentive-related benefits.

Use Case 2: Flexibility for incentive-related improvement

In some cases, the user may be considering the use of flexibility not to defer reinforcement, but to address some other issue on the network. For example, flexibility might be able to reduce customer outages, thereby improving Customer Interruptions and Customer Minutes Lost (CIs & CMLs) and other customer service metrics.

To reflect this in the tool, on the **Baseline Reinforcement** tab the user should set the exceedance value to zero across the horizon (i.e. delete the input load or exceedance) and set the 'Baseline reinforcement and upfront capex' to zero. This will set the 'Intervention start year' to the start of the modelling horizon. The model will then simply compare the cost of flexibility (summarised in the **Flex Costs Summary** tab) to the net benefit associated with the inputs on the **Incentives, Penalties and Societal Impacts** tab.

As with all Use Cases, the user needs to ensure that the flexibility costs specified are consistent with what can be procured, and that they are specified for the entire modelling horizon. If the user only provides flexibility costs for 5 years, for example, but shows incentive-related benefits for 45 years, the model will infer that after the first 5 years the cost of flexibility is effectively zero. If the user only wants to consider up to 5 years of NPVs they can either set both the flex costs and incentive-related benefits to zero from year 6 onwards, or can use the 'Last date at which strategy can be effective' parameter in the **Control** sheet to a value 5 years after the model start year.

The **Analysis and Insights** tabs can be interpreted in much the same way as in Use Case 1, although the tables will no longer refer to "deferral length". Rather, the NPV of a strategy at, say, year 5 simply means the NPV of using flexibility for 5 years and receiving 5 years of incentive-related benefits.

Use Case 3: Energy efficiency to defer reinforcement

Rather than using DSR or similar, a DNO might want to investigate using some sort of efficiency drive to reduce network peak loading, and hence defer reinforcement. In many ways, the model can be populated in exactly the same way as for a classic 'flexibility' example.

For example, upfront and annual fixed costs can be included to refer to the cost of setting up the scheme and maintaining it. If the efficiency drive has some volume-related incentives (e.g. payments for peak load reduction) this can be reflected as a form of estimated availability or utilisation payment. What matters for the NPV calculation is that the total annual 'flexibility' cost is equal to the expected annual cost of delivering the energy efficiency scheme.

On the reinforcement side, the user will need to ensure that the deferral for each year is achievable with the efficiency strategy, and that the 'flexibility' cost is consistent with that. The model will then say whether the cost of efficiency in that year is justified given the deferral achieved and the incentive-related benefits.

One key difference between DSR and energy efficiency is that, potentially, efficiency has lasting benefits once the scheme is no longer active. For example, if the scheme involves replacing light bulbs with LEDs, the carbon benefits should endure even once the scheme ends. However, ***this model is not designed to reflect this case since it cannot show the incentive-related benefits enduring whilst the deferral-related benefits do not***.

Take the situation where the user wants to model implementing an efficiency scheme for 5 years, deferring reinforcement for 5 years, but getting a further 5 years of CO_2 reduction benefits. The user could enter 'flexibility' costs for 5 years, but shows emission-related benefits for 10 years. However, when reading off the 10-year benefit in the **Analysis and Insights** tabs this will implicitly include the benefit of deferring reinforcement for 10 years. The user has two possible work-arounds:

1. **Run the model twice**, looking first at the benefit of deferral (over 5 years), then the benefit of CO_2 reduction (over 10 years). The user can then combine the NPVs outside the model, which makes it difficult to interpret the results. The user will also need to ensure that the cost of the efficiency is not double-counted; or
2. **Reflect the enduring CO_2 benefit in year 5:** The user inflates the CO2 benefit in year 5 to reflect the additional benefit that would have occurred in years 6-10. The user will then read off the NPV in year 5. Strictly, the user would need to account for the discounted value of CO2 reduction in years 6-10.

Use Case 4: Active Network Management (ANM)

It should be noted that this CBA tool is deliberately designed to give the DNO's perspective on its costs and benefits. It is not intended to account for the costs and benefits of a connecting party, for example.

If a customer wishes to connect to a DNO's network, some of the costs of connecting that customer are paid by the connecting party, and some are paid by the DNO. In additional to conventional connection offers, DNOs are increasingly offering Flexible Connections which include some ANM costs, some reinforcement costs (although smaller than for the conventional connection offer) and an obligation on the connecting party to accept curtailment when the network is constrained.

As with conventional connection, under Flexible Connections there are certain costs that are covered by the DNO rather than the connecting party. These are defined in the as per the Common Connections Charging Methodology (CCCM), and are summarised in Table 1.

Table 2   CCCM cost recovery associated with Flexible Connections

Typical connection components[1]	Type 1A - Single	Type 1B – Multiple	Type 2 – Wide Area
Extension Assets for customer	You fund	You fund	You fund
End user control unit for the customer	You fund	You fund	You fund
Local system management unit	You fund	Shared equally between participants	We fund
Scheme management unit	You fund	Shared equally between participants	We fund
Central management unit	N/A	N/A	We fund
Scheme specific ongoing costs e.g. communications	We fund	We fund	We fund

The DNO can use the CEM CBA tool in a number of ways.

DNO's costs under conventional vs ANM connections

A DNO can use the CBA tool in order to determine whether it is cheaper for it to offer a conventional connection or a flexible connection. In order to do this, the following steps should occur:

▶ In **Baseline Reinforcement**, set all exceedance and reinforcement costs to zero (note, even though we may be considering reinforcement, this is not a 'deferral' use case, so these costs should not be included in this tab

▶ Set all **Incentive and Penalty** inputs to zero

▶ Define two strategies for each scenario, e.g. "Conventional" and "ANM"

▶ In either the **Flex Volume and Cost Inputs** tab or the **Flex Cost Inputs** tabs (depending on the *flex_cost_input_type* setting on the **Control** tab), describe the DNO's estimates of its costs under a Conventional and a Flexible connection. This is likely to be some combination of upfront and ongoing fixed costs. Note, this may include some reinforcement costs, but these should still be included in this tab. It is advisable to include costs over the full (45 year) modelling horizon, even if that involves inputting zeroes.

The user can then look at the Analysis and Insights tabs to determine which strategy (conventional or ANM) yields the highest NPV for the DNO over the whole modelling horizon.

Using flexibility to avoid connection-related reinforcement

This Use Case could apply for either conventional or flexible connections. As mentioned above, when a customer connects to a DNO's network, some network reinforcement can be required. The DNO incurs some of the costs associated with that reinforcement. The DNO can use the CBA tool to determine whether it makes sense to avoid or defer that reinforcement through the use of flexibility contracts. This could equally be applicable to conventional or ANM connections, although the reinforcement cost is typically higher in conventional connections.

To reflect this Use Case, the user would take the following steps:

► Input the connection-related reinforcement cost *attributed to the DNO* in the **Baseline Reinforcement** tab

► Set the exceedance to the value that the DNO estimates is created by the new connection

► Input the flexibility costs that the DNO estimates it would incur to manage that level of exceedance (and hence defer the need for reinforcement)

► If there are any incentive-related benefits, the user can input these as in the standard flexibility use case

In other words, this Use Case is no different from the normal flexibility use case except for the fact that *only the DNO* share of reinforcement costs is included, rather than the total cost that would be typically included for load-related reinforcement.

Other possible ANM use cases

It may be possible to use the CEM CBA tool to examine other use cases related to ANM, but a number of those being considered involve accounting for the costs associated with the connecting party. By design, this tool has a DNO lens (with accounting treatment that is specific to the DNOs). Regulations around network access and charging could change in the future, which may change the costs and risks attributable to the DNOs. This could increase the number of use cases for which this tool is suitable, for example addressing:

► Whether it is cheaper for the connecting party to face the opportunity cost of curtailment under ANM or instead to manage the constraint by procuring flexibility services or enacting a local flexibility market.

► Whether the levels of curtailment being faced by ANM customers justifies the reinforcement of a network to alleviate the constraint.

In both these examples, the opportunity cost of curtailment is an important factor, but is one not faced by the DNO. As noted above, these Use Cases could be addressed through the CEM tool if this were changed by regulatory reforms.