**Methodology for assessing the value of flexibility as an alternative to network reinforcement**

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## Overview

The trifecta of decarbonisation, decentralisation and digitalization is guiding the energy transition across the EU member states. In this context, the design and roll-out of initiatives that facilitate active electricity distribution system management is an integral part of the envisioned transition of European Distributon Network Operators (DNOs) to Distribution System Operators (DSOs). This transition will see DNOs increasingly taking on the responsibility of actively managing the distribution grid through deployment of Distributed Energy Resources (DER) to alleviate network constraints. The Clean Energy for All European Packages envisages DSOs of the future will increasingly be involved in peak load and network constraint management using flexibility services provided by different types of DER - not just different types of distributed generation, but also dispatchable loads, electric vehicles and energy storage. A key question revolves around what the value of using such flexibility is for DSOs, how this value compares with traditional capex solutions (building more network) they would ordinarily deploy, and whether the value is sufficient to compensate those providing this flexibility.

## Methods

## Through application of a real options approach, we have developed a conceptual investment decision-making framework for evaluating options around deferring DSO network reinforcements planned to address a network constraint, say by entering into a contract with a flexible resource to resolve the network constraint. Under such a framework, for any given decision, a first step will be to define the range of actions which a DSO can take today in relation to a potential future problem in relation to network capacity. These might include, for example:

## reinforce the network – which might in itself cover small or large reinforcements, or potentially staged reinforcements ;

## draw on user flexibility – which again might include different levels of flexibility provision; or

## doing nothing, to wait and see whether the reinforcement is actually required.

Having defined the set of actions, a sense of the potential outcomes resulting from different actions needs to be assessed. These outcomes should include:

## the direct costs of the action (i.e. opex or capex); and

## the indirect costs, including (e.g. for “do nothing” or smaller investments) some assessment of the cost of potential congestion, overloading or interruption on the network if it were to materialise, as well as potentially changes in network losses.

The indirect costs (and possibly the direct costs) will depend on future states of the world – which could include the level of background demand growth, growth in new uses (e.g. EVs, heat pumps), and the growth in storage and/or distributed generation on the grid (or behind the meter generation). For example, congestion or overloading may be significantly more likely if there is high load growth in particular areas (e.g. clustered uptake of EV or heat), or if there is new generation development in generator dominated areas. This implies that the cost of not reinforcing (or undertaking delayed or smaller reinforcements) may only be high in such states of the world, and that the cost is expected to be lower if there is (for example) lower load growth. The cost of different outcomes needs to be defined against different such states of the world, which need to have probabilities attached to them.

Based on these indirect costs, we can calculate the total costs to society of different actions under different states of the world. We assume that the state of the world is not known at T=1, but will become known at T=2.

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| Figure 1 Total cost by scenario |
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| Source: Frontier Economics |

In this simple example, we assume that in the timescale under consideration there are no other decisions (e.g. on other parts of the network) which impinge on this particular decision – in other words, the decision can be considered in complete isolation.

From this information, we can then work out the action at T=1 with the **lowest expected cost**. To do this, we work out what the optimal actions would be at time T=2 (i.e. once the state of the world is known with certainty). These are circled red in the diagram above. For example, if the action taken at T=1 was to use flex, then at T=2:

## if it is clear that S1 is going to materialise, the best action is to undertake a minor reinforcement (cost of 20 vs. 25); and

## if it is clear that S2 is going to materialise, the best action is to rely on flex (cost of 5 vs. cost of 15).

Having worked out the optimal action in each scenario, at T=1 the expected payoffs to each T=1 action can be worked out using this information, combined with the probability (as seen at T=1) that each state of the world will occur.

## Results

## We have built the framework described above into an excel model that assesses for a given set of assumptions around costs, states of the world, associated probabilities of these states materializing, the optimal decision for the DSO. A sample output is shown below, where the model is seen to select a flexibility option (CMZ) over conventional reinforcement in a low demand state of the world and chooses conventional reinforcement otherwise.

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| Figure 2 Optimal investment choice by decision-making stage and scenario |
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| Source: Frontier Economics |

## Conclusions

Given the inevitable material uncertainty about the inputs – the model cannot be viewed as an automated decision tool. By imposing a structure on thinking, the model forces thinking about the drivers of the optimal outcome and therefore helps answer the question “what would I need to believe for this to be the optimal action?” Additionally, the model can help highlight key areas of ambiguity to support and be informed by wider stakeholder engagement.