Schedule 1: Didactic description of the GCE Fixing mechanism.

Introduction

This document provides an explanation of Fixing algorithm developed by Belpex in the context of the Green Certificates **Exchange Platform (GCE).** This document is part of the Functional Appendix and aims to propose a didactic description on how the **Fixing Price (FP)** and **Fixing Volume (FV)** will be determined by the algorithm based on the order book.

The general principle of a fixing procedure can be described in many ways. The approach chosen in this document is graphical and consists of intersecting **Supply and Demand Curves (SDC)**. This document hence does not describe the technical procedure that is implemented in the **GCE** (i.e. the GCE algorithm itself, for which a description can be found in the Functional Appendix). Rather, it provides an explanation on how **FPs** and **FVs** are determined based on less formal descriptions and graphical examples.

The document is split in two parts. The first part describes how **SDC** are built, and provides some graphical examples of **SDC** intersects. The second part explains the ad hoc rules chosen for those cases where **FPs** or **FVs** can not be unambiguously determined by SDC intersections.

Part 1: Finding clearing prices and volumes

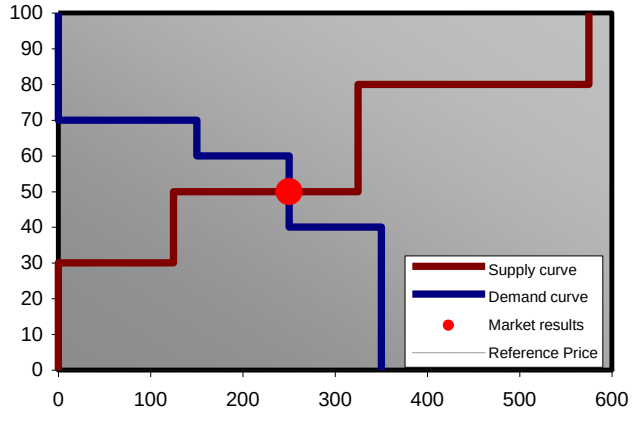
Supply and Demand Curves (**SDC**) are build based on the merit order principle which prioritizes the orders according to their Limit Prices so as to fulfill firstly the cheapest sell orders and the most expensive purchase orders. Graphically, this means that **SDC** are stepwise monotonous curves.

In the example hereunder, the order book contains three sell orders at price levels of 30 €, 50 € and 80 € for volumes of 125, 200 and 250 **Tradable Instruments (TI)** respectively. Hence, the supply curve contains three stacked (horizontal) steps: a first step of 125 **TI** at 30 € (from 0 to 125 **TI**), a second step of 200 **TI** at 50 € (from 125 to 325 **TI**) and a third step of 250 **TI** at 80 € (from 325 to 575 **TI**). These (horizontal) steps are complemented with vertical segments so that the supply curve is continuous between the minimum and the maximum price (0 € and 100 € respectively in this example).

The demand curve is build similarly and contains three steps (150 **TI** at 70 €, 100 **TI** at 60 € and 100 **TI** at 40 €), but the construction is done using purchase orders in decreasing Limit Prices order.

Price	Supply	Demand
100 €		
80 €	250	
70 €		150
60 €		100
50 €	200	
40 €		100
30 €	125	
20 €		
10 €		

Reference Price: 0 €



With this example, the intersection of the SDC shows a **FP** of 50 € and a **FV** of 250 **TI** at the intersection of the SDC. The intersection appears on the second step of the supply curve at a price level of 50 €, which has the consequence that only 125 **TI** of the orders are 50 € can be fulfilled.
Note that in case there are more than one order at 50 €, the orders will be fulfilled on a "First In First Served" basis using the timestamps of the order submission.

Part 2: Solving indeterminacies

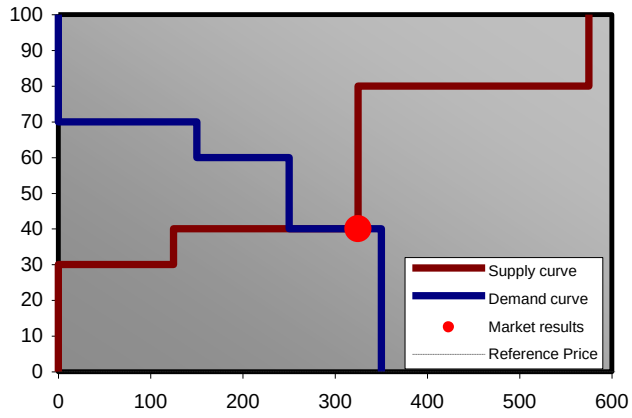
In the example presented above, the **FP** and **FV** are uniquely determined by the intersection of **SDC**. However, it might be that **SDC** do not intersect at a single point. In such a case, the results can not be uniquely determined and ad hoc rules are needed to solve the indeterminacies. Such "indeterminacy rules" are necessary in case of either horizontal overlaps (i.e. volume indeterminacies) or vertical overlaps (i.e. price indeterminacies).

Volume indeterminacies

Volume indeterminacies happen when **SDC** present horizontal overlaps. In the following example, **SDC** present a common segment at the price level of 40 €, so that the **FV** can in principle take any value between 250 and 325 **TI**. In such a case, the **GCE** chooses the largest possible **FV**. Graphically, this means that the chosen point is the one on the right hand side of the overlapping segment.

Price	Supply	Demand
100 €		
80 €	250	
70 €		150
60 €		100
50 €		
40 €	200	100
30 €	125	
20 €		
10 €		

Reference Price: 0 €



Price indeterminacies

Price indeterminacies occur when **SDC** overlap on a vertical segment. In such a case, several ad hoc rules are implemented in the **GCE.**

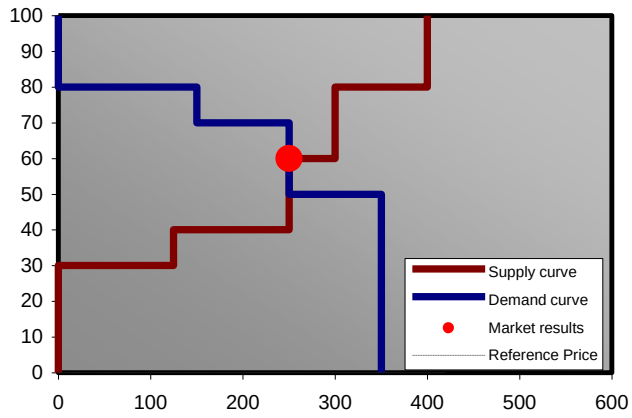
The least unfulfilled Tradable Instruments

The general idea of this rule is to select amongst the highest and the lowest possible **FPs** the one for which the smallest amount of **TI** are unfulfilled.

In the following example, all points in the range [50 €; 60 €] are on the intersection of **SDC** and would be valid **FPs**. At a **FP** of 50 €, there are 100 **TI** of the cheapest purchase order which are unfulfilled although the Limit Price of the order is compatible with the **FP**. At a **FP** of 60 €, there are 50 **TI** of the third supply order which are unfulfilled although the Limit Price of the order is compatible with the **FP**. Because the amount of unfulfilled **TI** is smaller at 60 €, this **FP** is chosen by **GCE**.

Price	Supply	Demand
100 €		
80 €	100	150
70 €		100
60 €	50	
50 €		100
40 €	125	
30 €	125	
20 €		
10 €		

Reference Price: 0 €



The closest to the reference price

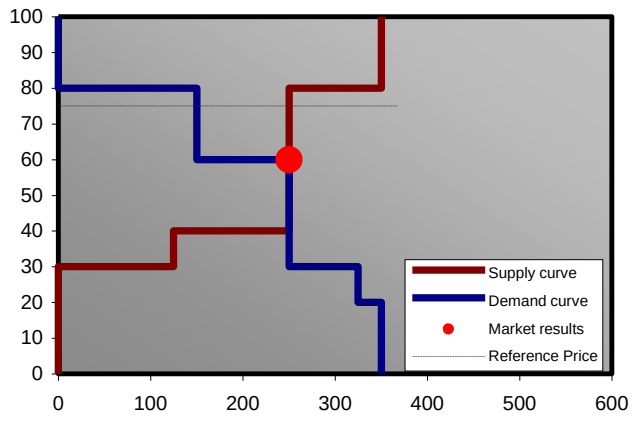
In case it is not possible to choose a unique **FP** based on the "least unfulfilled Tradable Instruments" criteria as described above, the algorithm will select the valid **FP** that is the closest to the Reference Price.

In the example below, all **FPs** in the range [40 €, 60 €] are valid, and no **TI** compatible with any of these **FPs** would be unfulfilled. Hence the rule described above can not determined unambiguously the **FP**.

As the reference price is 75 €, the closest feasible price is 60 €, which is the one returned by the **GCE**.

Price	Supply	Demand
100 €		
80 €	100	150
70 €		
60 €		100
50 €		
40 €	125	
30 €	125	75
20 €		25
10 €		

Reference Price: 75 €



Note that if the Reference Price is within the range of feasible **FPs** (i.e 48 € as in the example below), the **FP** chosen by **GCE** is this Reference Price, since it is literally the valid **FP** closest to the Reference Price.

Price	Supply	Demand
100 €		
80 €	100	150
70 €		
60 €		100
50 €		
40 €	125	
30 €	125	75
20 €		25
10 €		

Reference Price: 48 €